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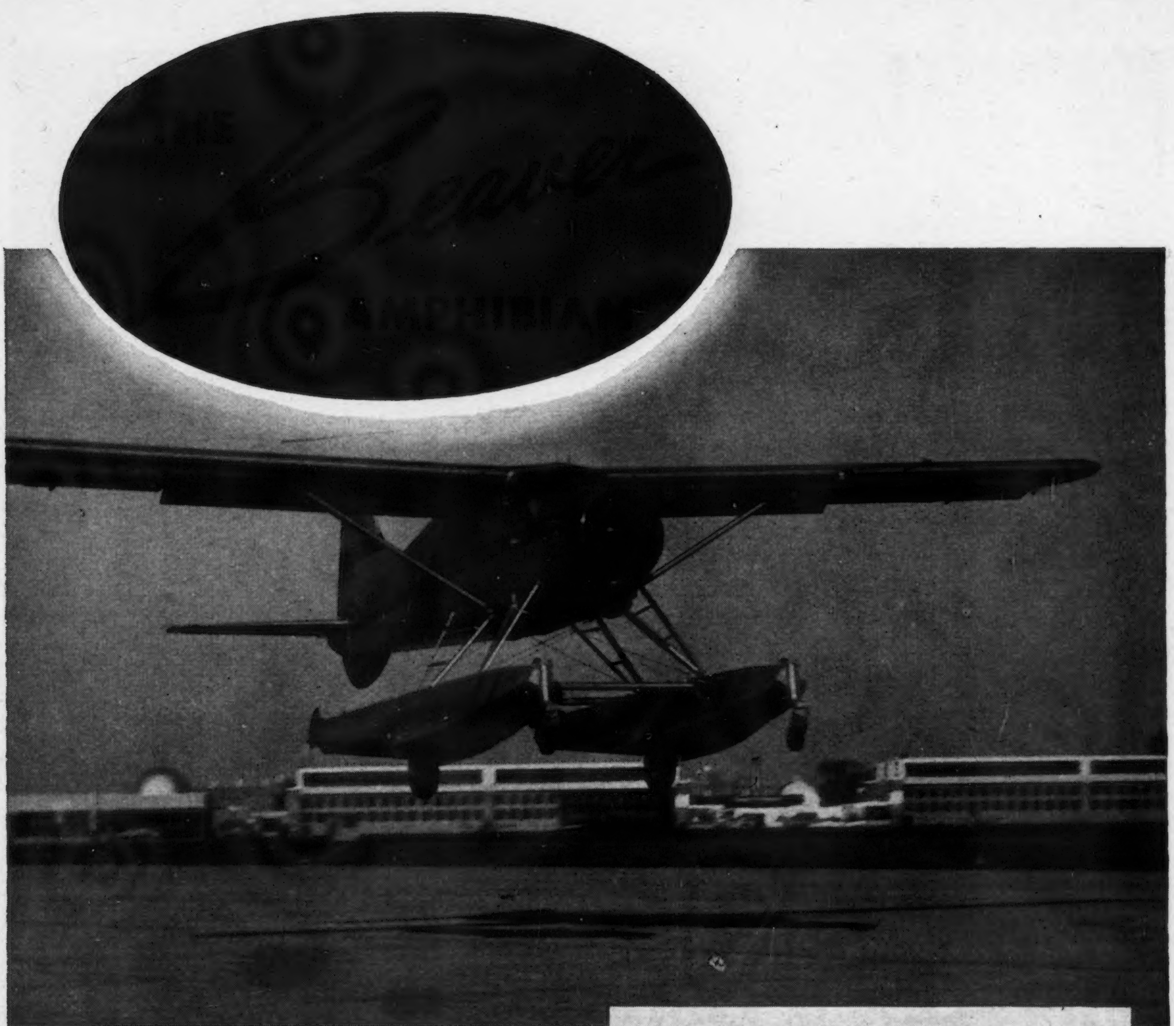
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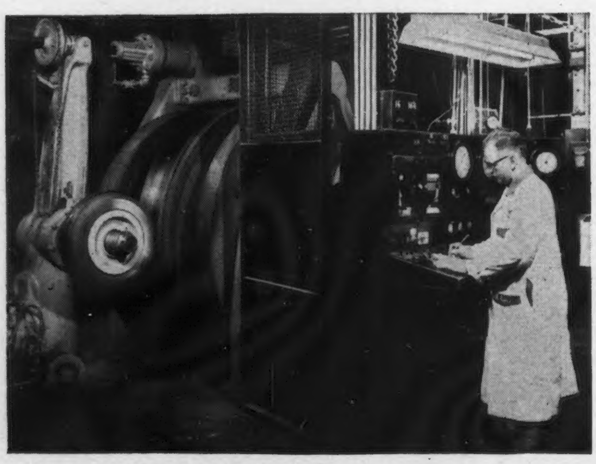

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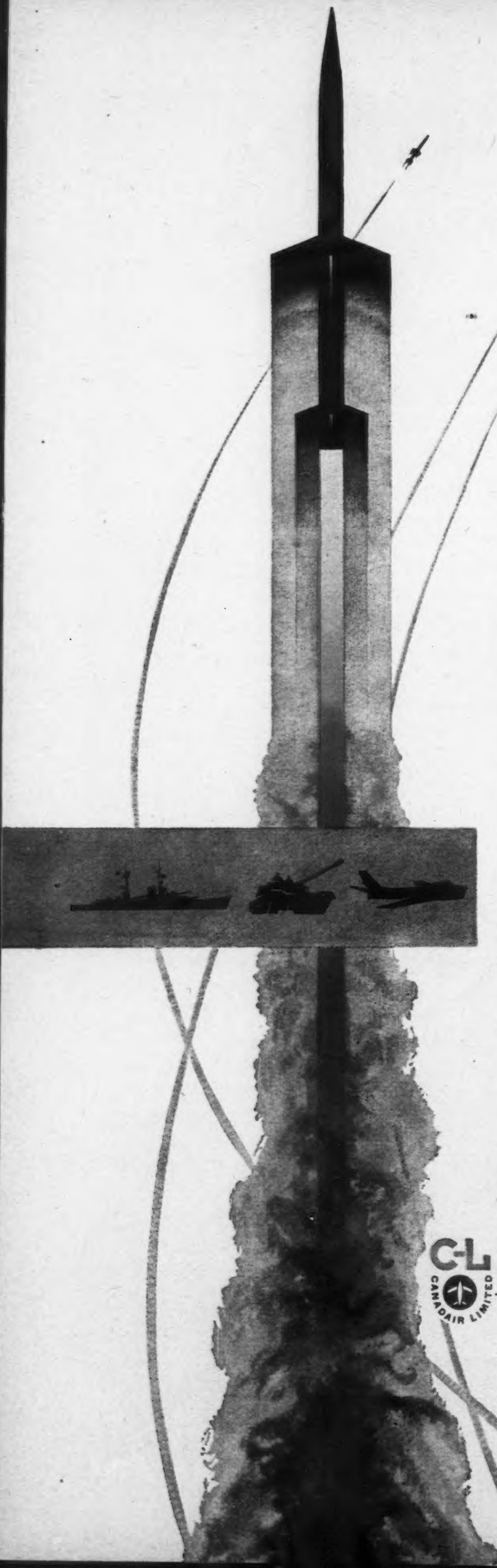
Tire to be tested is placed in contact with a 120" diameter flywheel which is controlled from the panel at right. Operator can simulate landing loads up to 60,000 lbs. Inertia equivalent of flywheel can be varied from 7,500 lbs. to as high as 50,000 lbs. Flywheel speeds obtainable up to 250 m.p.h.



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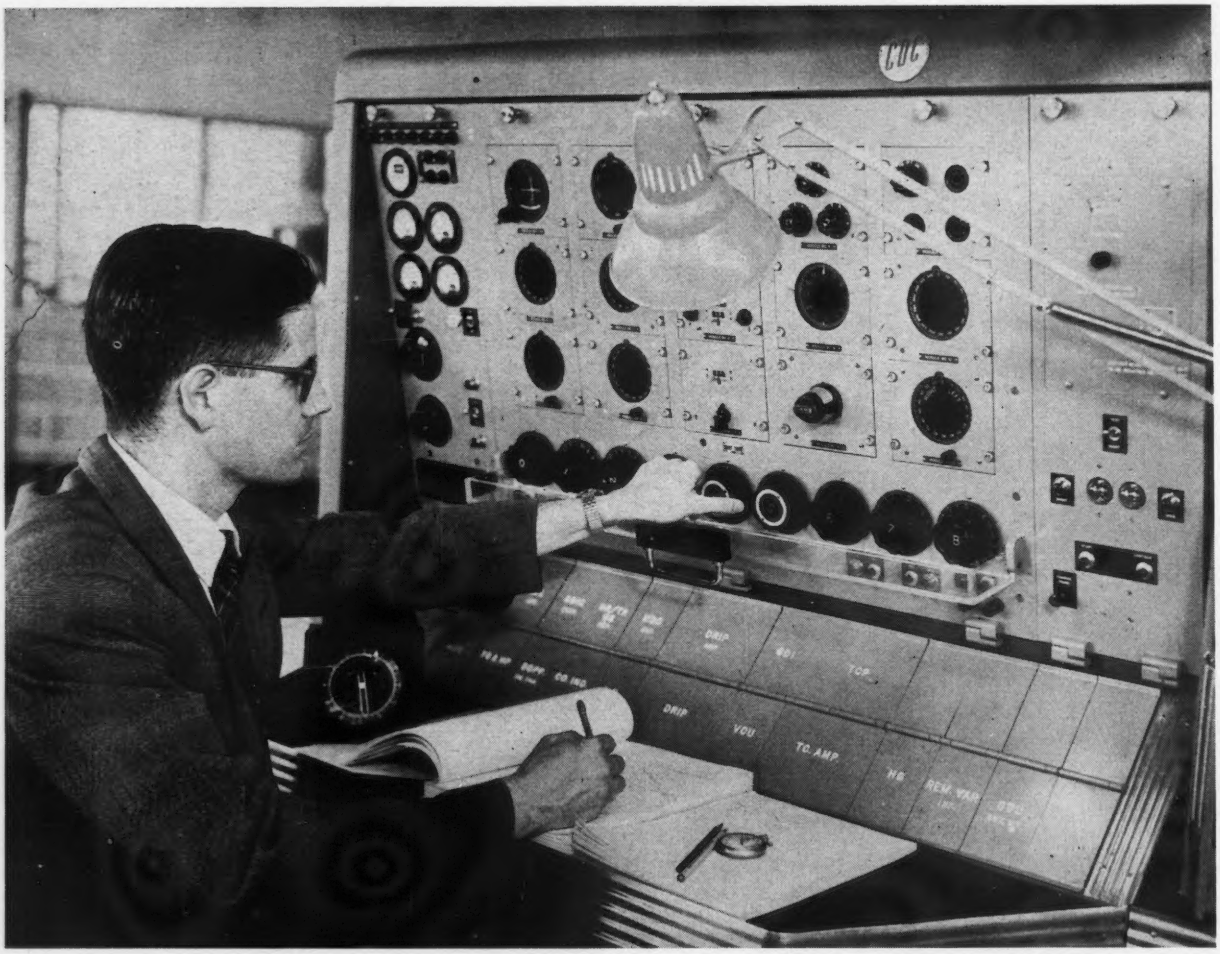
ANTAC TEST CONSOLE



The test console designed by Computing Devices of Canada Ltd. for checking the units of their ANTAC system. **(See page 114)**

EDITORIAL

OFF THE GROUND

WALTER de la Mare wrote a delightful poem with this title. It started

Three jolly Farmers
Once bet a pound
Each dance the other would
Off the ground.

It ended with Farmer Turvey disappearing into the sea and being declared the winner:

"For it's sartin sure, Turvey,
Safe and sound
You danced us square, Turvey,
Off the ground!"

Now it is not suggested that the Canadian Aeronautical Institute should concern itself with marine (or even submarine) dancing. But we should like to make the point that we regard the term "aeronautical" as including "astronautical" and, in fact, any other condition which involves being "off the ground". This was understood from the very first. When the name of the Institute was chosen, the original Steering Committee looked into the future as well as into the past and considered the desirability of choosing a more open name, which could include astronautics. They decided to stay with the past and to base the name on those of the Royal Aeronautical Society and the Institute of the Aeronautical Sciences. This decision was reached, not because of any intention to exclude astronautics, but because aeronautics had become associated with anything that was "off the ground" – with "flying" if you like.

Aeronautics, in its literal sense, and astronautics may have important differences but, so long as man lives on the Earth and breathes air, he cannot become an astronaut without first practising the arts of aeronautics; and he must again practise these arts when he comes home. Moreover the practice of these aeronautical arts is likely to be always the most difficult part of his journey. From what the astronauts tell us, it will be no trick at all to flit from planet to planet, starting from a spaceport orbiting the Earth, well outside our infernally uncooperative atmosphere.

It is impossible to draw any significant line between astronautics and aeronautics. The one stems directly from the other and the arts, sciences and engineering of the one are, with a few exceptions, developments of those applying to the other. The aerodynamicist is extending his work into aerophysics; the propulsion engineer is exploring the non-airbreathing engine; structures and metallurgy, electrics and electronics, medicine and human engineering, guidance and navigation, and many others – these are all common to both. Both call upon the same research facilities, the same manufacturing industry and the same men.

For these reasons, the Institute of the Aeronautical Sciences has openly stated its interest in satellites and spacecraft. Since our resources in Canada are scarcely big enough to support two societies interested in the subject, we have already undertaken to cover the field of the American Rocket Society on this side of the border and, as announced on page 143 of this issue, the establishment of a Propulsion Section is the first result. In view of the growing interest in other aspects of space travel, the President has now appointed a Committee to study the feasibility of establishing an Astronautics Section.

The object of the Institute, as expressed in the By-laws, is to advance the art, science and engineering relating to aeronautics. As pointed out above, these are essentially the same art, science and engineering as those relating to astronautics. However the word "aeronautics" may be interpreted, the Canadian Aeronautical Institute has a clear responsibility under its Charter to concern itself with the art, science and engineering of anything that gets "off the ground".

ANTAC SYSTEM

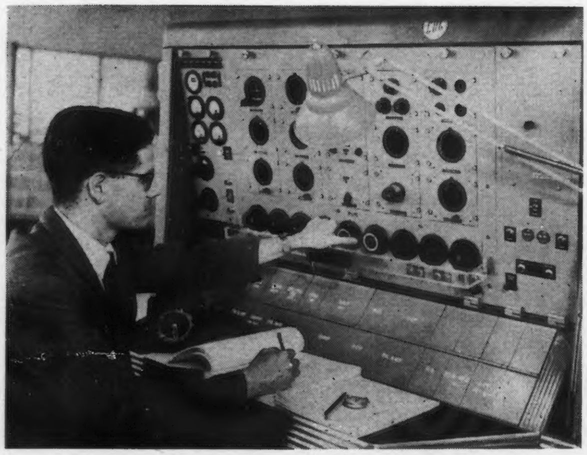
THE navigation system for an aircraft like the Argus, intended for long range flights over open ocean, far from conventional land based navigational aids, must necessarily be a complex, yet nearly foolproof, system.

ANTAC (Air Navigation and TActical Control) was developed to meet the rigorous requirements of the Argus. Almost completely automatic, it is primarily a long range dead reckoning navigation system with provision for coupling to doppler radar, Tacan and conventional radio aids where available.

Each of the major sub-systems was a sizeable development project in itself. The Master Direction Corrector generates all aircraft heading information, supplies correction as needed, and transmits the type of heading required for each different crew member or function in the aircraft.

To check on the heading system, a Synchronous Astro Compass system is included. With this, the pilot can make a quick simple check through a servo driven periscopic sextant on the azimuth of a preselected star to determine if the heading information is correct.

The Integrated Destination Indicator uses heading information from the Master Direction Corrector and position information from the Dead Reckoning Computer, to supply heading, bearing and distance information to the pilots.



Master Direction Corrector on test on the ANTAC test console

In addition to the long range navigation features, there is also a short range Tactical Navigation system.

Extensive cabling is needed to tie all of the forty-odd black boxes together in the aircraft. Some of the units connect to as many as 150 wires in five separate cables.

Testing of such complex circuitry is simplified by the use of the Antac Test Console illustrated above.

Designed to test 24 different units in the system, the test console checks the individual wires for opens, shorts and grounds, and feeds simulated inputs to test operation and accuracy.

An automatic stepping switch cycles through open and short tests between all combinations in pairs of 100 different wires in 27 seconds. An experienced technician would spend several hours doing this by conventional means. If a fault is detected, the cycle stops, indicating the location, until the operator restarts the cycle.

Complete simulation tests on some units may be a lengthy procedure. This is because some of the tests for accuracy must continue for a long enough period of time for an error to become detectable.

This composite photograph shows most of the components of the ANTAC system

OUR EDUCATIONAL RESPONSIBILITIES†

by E. C. Wells*

Boeing Airplane Company

Mr. E. C. Wells

At the time of my election as President of the Institute of the Aeronautical Sciences, I did not know that one of the first official invitations I would receive would be that which brings me before you tonight. It is a special privilege for me to speak to you, first, to speak in Canada, because I hold your country and my friends in your organization in high regard, and second, to speak in British Columbia, because in many years of cruising and vacationing in your beautiful coastal waters, I have developed such a deep appreciation for your friendly hospitality and for your magnificent scenery.

Tonight, as one representing a scientific society, speaking before another scientific society, I might logically be expected to espouse the cause of science, scientific education, or scientific organizations. If logic so demands, I hope you will bear with me if I speak on a somewhat broader plane and espouse instead the thought that as we pursue our scientific objectives we need not lose sight of other objectives.

It must be clear to all by now that the world is entering a new era, as measured in scientific terms. It is not at all clear, however, that this new era will necessarily be a better age for mankind. In recent years, man has advanced in his material standard of living and, although many will not agree with me, I am inclined to believe that there has been at least some small degree of greater appreciation for the importance of a balance between the material and the other aspects of human existence.

As we enter what some have elected to call the "Space Age", what does the future hold for us beyond some measure of military and scientific accomplishment? Does it even promise any further materialistic advancement? Some of the answers will depend upon our objectives in education, scientific or otherwise, and I would like to discuss this area with you for a short time this evening. Not being an educator, I cannot presume to answer these questions in any conclusive fashion. However, I hope that in asking them I may stimulate your thought, your imagination and possibly your action – and to that end I will offer tonight an expression of hope tempered with caution.

The pessimists among us may well ask – Why hope? For one thing, the fact that we have ourselves under critical review is in itself a cause for hope.

In no small measure my hope is founded upon the promise that we, who are interested in scientific endeavor and therefore in scientific education at a time when it is up for critical review, will more than any other group determine whether our society becomes more materialistic or whether we guide our new knowledge into the development of more lasting values.

Now please don't misunderstand me. There are many today who say we must make a clear choice. If we choose an adequate national defense, we must perforce give up all material comforts – or if we look toward material objectives we must turn our backs on everything else. I do not believe our choices consist of all black versus all white. I do believe that we have a job to do in defense and a responsibility in the direction of continual improvement in our standard of living. But, in addition, those of us involved in science and engineering must also take the lead in efforts to reinforce our society in other than military, scientific and material areas.

Why, you may ask, is this any responsibility of ours? Is not there a clear need for more scientists and engineers? Is not our first responsibility to help meet this need? And to meet this need must we not produce by education or otherwise a substantially larger number of scientists and engineers? It is here that I would temper hope with caution – let us first examine the popular assumption that there is such a clear need for more scientists and engineers.

†Dinner address read at the Mid-season Meeting of the C.A.I. in Vancouver on the 28th February, 1958.

*Vice-President, Engineering;
President, Institute of the Aeronautical Sciences.

WHAT IS THE REAL NEED?

Many who are in a position to judge will claim that our need is for better rather than more scientists and engineers; in fact, many feel that the need is for better trained and more intelligent people in all professions and occupations, rather than more people of average capability trained in one or more particular professions.

Our educational systems of today are not established in such a way as to be readily shifted from one emphasis to another in short order. To make this possible, even if desirable, would require the kind of overhauling which we are hardly ready or able to undertake.

Unless there is an unmistakably clear, long-term requirement for a major shift toward concentration on scientific training, we should not attempt without due consideration either an immediate short-term shift in emphasis, or a complete revision in our methods to make possible more ready future changes to specific special areas of training.

To be realistic, we must remember that if we could be successful in changing our methods for only the college years, four years would elapse before the effect could be fully felt. Should our change prove to be ill-advised, another four years must elapse before its correction could be fully effective. On the other hand, if improved quality of training is our objective in all fields, the probabilities are strong that time would prove the attempt to be a step in the right direction.

If we can agree for the moment that we need and desire quality before quantity, can we also agree that quality is not likely to be the result of a major quantitative change in emphasis only? Similarly, if we agree that quality is needed and desired in training of all kinds, can we achieve this objective if we over-emphasize one currently popular area, perhaps at the expense of others?

In a moment, I would like to suggest a course of action for your consideration, but first, because it seemed to me so pertinent, I would like to quote from an editorial which appeared this week in *Science* – the journal of the American Association for the Advancement of Science.

The writer pointed out that there is a difference between strategy and tactics in our educational planning and that the two are too often confused, with enthusiasm being developed for short-term efforts without consideration of overall or long-term implications.

He continues, "That the cultural, economic and scientific development of the future is being determined by what we do in the schools today has been said in many ways by many people. Internationally, also, the relations between policy and education are gaining attention. In the current issue of *Foreign Affairs,* Lloyd V. Berkner argues that because military power has become absolute – one nation can annihilate another, or be annihilated – it has become of reduced effectiveness in international relationships and the winning of allies. Similarly, wealth is of lessened power in this regard. Intellectual pre-eminence", Berkner continues, "is the new force that is replacing military strength and wealth . . .

"The problem of using education as a maximally constructive force in national and international policy (not just military policy), while at the same time preserving traditional values, poses an exciting challenge to political and educational statesmanship." The writer then discusses problems such as the financing of education and continues –

"Perhaps more important is to agree on a set of values and objectives that will give the whole educational venture the status it must have if it is to serve effectively in this larger role and that will accommodate our different but not necessarily conflicting values of aiding the handicapped, serving the average, and developing the superior student, each optimally in terms of his own capacities and potentialities."

In concluding, he makes what I believe to be somewhat of an understatement – "A concerted attempt to solve these problems is an altogether seemly enterprise."

WHAT WE CAN DO

Now for some thoughts on how to undertake this altogether seemly enterprise.

(1) By way of preparation, we should endeavor individually to become better informed and to encourage others to do so.

(2) If the facts indicate that the need is for improved quality rather than increased quantity of scientific education, we should employ our individual and collective resources to establish and support programs directed toward a quality objective.

(3) If the facts further indicate that a balanced high quality educational program is preferable to one with increasing emphasis on scientific subjects, we should similarly use our efforts to support such balanced programs.

(4) If the facts indicate that we cannot continue to increase the numerical quantity of people subjected to a so-called higher education without reducing the quality of education for those capable of assimilating and using a superior type of training, then we should direct our efforts toward the maintaining of quality, with higher eligibility standards being employed to limit quantity. If this sounds un-democratic, I'm sorry – perhaps I'm somewhat reactionary in my feeling that everyone should have an opportunity for the best education he can qualify for, but no one has a right to continue to receive instruction far beyond the point where he fails repeatedly to qualify on any reasonable basis of evaluation.

If we as individuals do make the effort to be better informed, and in becoming informed make the corollary effort as individuals to take part in educational programs within our own spheres of influence, I believe that we might then be better qualified to act collectively – through organizations such as the Canadian Aeronautical Institute and the Institute of the Aeronautical Sciences – to institute improvements in our educational processes which would be of benefit to our civilization along a broad front, including accelerated progress in the fields in which we as scientists and engineers have had our traditional interest. This, I feel, we can do and are in a unique position to do.

If, as the saying goes, we "Let George do it", we can be sure that George will do it his own way.

If we want it done either in our way or the right way (and I hope the two are synonomous), we must first take an individual interest and responsibility.

AIRLINE PLANNING FOR JETS†

by J. A. Stern*

United Air Lines, Inc.

THIS year, 1958, will see the inauguration of a new era in the field of commercial air transportation — the Jet Age. And when jet transports are placed in commercial operation it will be the culmination of many years of exhaustive study and careful planning by both aircraft manufacturers and airlines. In view of the magnitude of this transition it is fortunate that, over the years, procedures and methods have been developed for the efficient and economical introduction of new equipment. The introduction of new equipment is a familiar challenge to the airlines. During the thirty years of its existence, United Air Lines has placed a completely new model of airplane in operation on the average of every two and a half years, commencing with the De Havilland DH-9. Then came the Boeing 95, 40B and 247, the Ford Trimotor and the DC-3. During the post World War II period came the C-54, the DC-6/7 series, the Boeing 377 and the Convair 340. In arriving at the introduction rate of an average of each two and a half years, successive versions of the same model (for example, the DC-6A and DC-6B) are considered to be one. This is a fortunate circumstance, as effort does not have to be devoted to the development of procedures; rather, it can be concentrated in the areas where jet aircraft are different from those presently operated.

This paper represents a summary of the technical planning necessary on the part of commercial transport operators for the introduction of large jet transports.

SELECTION OF AIRCRAFT

This planning actually commences during the airplane selection process, in itself an extremely complex and thorough analysis of the overall company requirements. In initially selecting the airplane that best fits a particular airline's route structure, it is necessary to accomplish many of the planning studies which will be required later for placing the airplane in scheduled operation. Selecting the airplane which most nearly meets the requirements demands that the peculiar needs of the flight operations, passenger service, and maintenance functions be carefully considered, as well as the particular airline's competitive situation. The ideal of the selection process is to obtain an airplane which meets the requirements of both sales and operating personnel while insuring minimum operating costs on both an airplane and seat-mile basis. In the efforts to obtain these minimum costs, cabin configuration demands particular attention. If a maximum number of seats were crowded into the available area, the minimum seat-mile costs would naturally be obtained. However, this arrangement might be utterly untenable from a competitive standpoint; hence, the final cabin arrangement must reflect a compromise between minimum seat-mile costs and saleability. But however optimum the cabin arrangement may be, it still must be ascertained that the airplane will satisfactorily meet the requirements placed upon it. Thus, consideration must be given to its operational and functional characteristics.

For example, if the field lengths required for takeoff and landing were excessive, it might not be possible for the airplane to operate economically into and out of the airports desired. Moreover, if the systems were not dependable and subject to efficient and economical maintenance, the airplane would not be satisfactory. In selecting the airplane then, close analysis is made of its complex of characteristics. This analysis takes into consideration the non-standard conditions encountered in day-to-day operations with special attention devoted to above-standard temperature effects on both the takeoff and cruise regimes. Planning based on standard temperatures is apt to be most unrealistic.

With respect to the mechanical, communication and instrument systems, reviews are made commencing with the preliminary type specifications and continuing through the evolution of a detail specification. This latter becomes a part of the airplane purchase agreement and subsequent changes are made as the detail design progresses. This process insures that, insofar as possible, the airplane will reflect the most up-to-date technological changes at any given point in its development. Thus, by the time a decision is made in the selection of a particular airplane, its mechanical systems and operational capabilities are well known. This preselection analysis will have indicated the various areas where planning efforts will be necessary to insure efficient introduction of the airplane.

FACILITIES

One of the first planning areas to which major efforts are devoted is that of facilities. Immediately after the selection is finalized, thorough studies are made to determine the necessary facilities that will be required to support the operation of the airplane. Primarily, these facilities comprise:

(1) runways,

(2) ramps and taxiways,

†Paper read at the Mid-season Meeting of the C.A.I. in Vancouver on the 27th February, 1958.
*Staff Engineer.

(3) terminal and passenger handling areas, and
(4) maintenance hangars and docks.

Runways

With respect to runway requirements, the simplest way to determine them would be to calculate the runways required by compounding the most adverse combination of conditions. This is unreasonable and uneconomical. In the final analysis, it is the airlines who pay for airport improvements. To illustrate such compounding of adverse conditions, let us base a necessary runway length on the following factors:

(1) the longest trip segment to be operated from the airport,
(2) the airplane of least power capacity,
(3) the highest fuel reserve requirements,
(4) high cruise speeds,
(5) high headwinds at cruising levels,
(6) high outside air temperature at takeoff and at cruising levels, and
(7) maximum payloads.

These conditions would, of course, define runways which would seldom be required in operations.

In determining the runway requirements to be requested at the various cities which United Air Lines will serve with jet transports, it was found most realistic to resort to a relatively complicated statistical approach. While twenty-one factors were given consideration, only the following were combined statistically:

(1) airplane performance characteristics,
(2) engine characteristics,
(3) departure times,
(4) surface temperature and winds, and
(5) en route temperature and winds.

In addition to the factors considered on a statistical basis, the influence of several other factors was reflected in the analysis on a "best judgment" basis, such as:

(1) pertinent Civil Air Regulations,
(2) airport restrictions,
(3) reserve fuel requirements,
(4) cruise control procedures,
(5) altitudes flown,
(6) thrust losses due to incorporation of sound suppressors, and
(7) the use of preferential runways to minimize noise over populated areas.

Using this information, plots were made for each airport of the chances of the necessity of off-loading a trip relative to the runway lengths. For each city an acceptable probability of off-loading was determined by management. For example, at a major terminal, such as New York, Idlewild, the off-loading of one trip per thousand was acceptable. At other terminals, Denver for example, a greater chance of off-loading was considered acceptable.

It should be emphasized that it is not possible to specify a single runway length as the standard for a particular type of airplane. Runway requirements at various locations differ widely and must be determined by individual analysis. This analysis requires the closest cooperation between airport management and the carriers utilizing the facilities. It is to the advantage of neither to have runways unfitted to the anticipated operations, being either too short or too long.

Ramps and taxiways

To be considered in conjunction with runway requirements are those for the ramps and the taxiways. The most important single consideration concerning these facilities is that they have sufficient structural strength to support the airplane. A second important consideration is the resistance of ramp and taxiway surfaces to the deteriorating influence of jet fuel spillage.

With the rapid increase in traffic through the airports of most major cities, it is vital that runway utilization capacities be increased. One method of accomplishing this increase is to better the runway acceptance rate. The acceptance rate of a particular runway can be increased if means are provided for the aircraft already on the ground to leave the landing runway in the shortest possible time. At the present time, the rapid evacuation of runways is not possible due to the fact that turn-offs are improperly located or of insufficient radii. Airplanes reaching an intersection are required to come to an almost complete stop before turning. In attempting to increase the capacity of landing runways at high density terminals, a considerable number of tests have been made of "high-speed turn-offs". The increase in runway capacity is achieved by allowing landing aircraft to evacuate the runway at the highest possible speed commensurate with safety.

Protection of crews and passengers

Not only must close attention be paid to the layout and design of runways and taxiways but the ramps adjacent to passenger and maintenance facilities have requirements all their own, peculiar to the jet airplane. Consideration must be given to the protection of passengers and of ground handling crews from the effects of jet noise and blast.

In this regard, ground handling tests have been conducted using the Boeing 707 airplane and a U.S. Navy A3D to simulate a DC-8. Specially constructed facilities were used in the tests, as well as the existing facilities at the San Francisco International Airport and the Seattle-Tacoma Airport where tests were conducted. These tests have indicated that a standard enclosed finger will be adequate to protect passengers from the effects of noise and blast. Inasmuch as the closure of these areas must be complete, some degree of air conditioning may be necessary.

It is important to note that the sources of outside air must be located in such a manner that jet exhaust fumes do not enter these closed areas. This is a problem that is still being studied.

The ground handling tests indicated that it would be possible to handle jet airplanes on the ramp in much the same manner as present types of aircraft, that is, taxied into and away from the parking position. Therefore, with respect to ramp crews, some degree of individual protection must be provided. Procedures must insure that a minimum number of personnel are on the ramp when engines are operating. This minimum number of personnel must be protected by the use of earplugs or other protective devices, and sound barriers must be provided adjacent to parking spaces for the

protection of personnel not actively engaged in the operation under way.

Airport terminals

Perhaps no airport facility is as conspicuous or as important to the public as the terminal building itself. Expansion of many existing terminals will be an unavoidable necessity. Even if these terminals were sufficient to handle the normal growth of airline business, it is extremely doubtful that they could handle the volumes of passengers that will result from the greatly increased passenger capacity of jet airplanes. An excellent example of this difference is the DC-8 airplane in the coach configuration; its capacity will be 132 passengers contrasted with the capacity of the present DC-7 coach of 72. This difference will accentuate passenger peaks.

It will make necessary larger waiting rooms, more ticketing facilities and larger passenger and baggage handling areas. It is interesting to note that a factor influencing the design of terminals and ramps is a policy requirement of many airlines — that the ground time for a jet transport must not exceed that of present aircraft. This policy demands pronounced improvement both in facilities and procedures for boarding passengers, fueling airplanes, handling meal services and handling cargo and baggage.

Refueling

To facilitate loading the increased quantities of fuel, the jet transports will be equipped for underwing pressure refueling. It is anticipated that all major terminals will provide facilities for pressure refueling from fixed hydrant installations. Only at the smaller terminals will it be necessary to refuel the airplanes from tank trucks. This is indeed fortunate, as it precludes the necessity of adding fuel trucks to a ramp already crowded with servicing equipment.

Baggage handling

For some time, it has appeared to the airlines that the most effective means of decreasing baggage handling time would be some system of pre-loaded container. It now appears that a cargo basket installation will become standard on most large jet transports. This system will allow the loading of cargo and passenger baggage in a specially constructed container, which can be hoisted into the airplane either from a specially designed combination cart-lift, or by a hoist system which is an integral part of the airplane. It is not hard to visualize the substantial advantages of a system which will do away with the present procedure of handling every piece of baggage and cargo several times over in its course from check-in to destination.

Development period

It should not be assumed, nor is it being assumed, that all necessary facilities will be available at all terminals prior to the commencement of jet schedules. Rather, it is anticipated that these facilities will become available over a period of four to five years. This means, of course, that considerable improvisation must be resorted to in the early phases of the operation. For example, some system of dock or fixed ramp, or gangplank for passenger use will undoubtedly become more or less standard as facilities develop. Some installations of this type are actually being tested and many are being studied. But even if conventional loading stairs must be used at first, it should be possible to streamline passenger boarding procedures and fully exploit the advantage of the presence of two passenger entrances contrasted with one on most present equipment. Not only will the two entrances allow emplaning and deplaning in minimum time but they also represent an ideal situation in cases of two-class configuration.

OPERATING PROCEDURES

Developing and making available the best possible facilities — runways, ramp services and terminals — is a big part of the job, but still, it is only a part of the job. As vital to the success of jet introduction as the facilities themselves is the manner in which they are employed to produce the end result of the most effective overall operation obtainable. This means operating procedures, and the development of these procedures is receiving almost the amount of attention that is being paid to the development of proper facilities.

Maintenance and overhaul

The early studies of the jet transports indicate that one result of their high speed will be the high utilization obtainable if the desires of the passengers can be reconciled with the airplane's requirements in terms of periodic checks, maintenance and overhaul. A study conducted by the Sales Departments of several airlines indicates that most passengers do not desire to leave before 8.30 am and wish to arrive at their destination prior to 10.00 pm. These preferences will have a direct bearing upon the utilization that can be obtained. For example, a jet transport leaving the west coast at 9.00 am would arrive at the east coast approximately at 4.00 pm. After a routine turn-around maintenance the airplane could depart the east coast at 6.00 pm, arriving at the west coast at 9.00 pm. There would then be a twelve-hour layover period. Consideration has also been given to the accomplishment of progressive overhaul conducted on an incremental basis during the period that the airplane is out of service during the night hours. At this time, while the possibility of conducting the progressive maintenance checks appears to be very good, progressive overhauls present many problems. These problems are still being studied.

There are a variety of reasons why maintenance and overhaul procedures are being developed with meticulous care. Not the least of these is the cost, approaching $300,000, of a podded, ready-to-mount spare jet engine. United Air Lines is planning to establish field repair facilities both at San Francisco and Idlewild. This is to avoid the current practice used with reciprocating engines of returning all engines requiring repairs to the San Francisco Maintenance Base and to reduce the number of spare engines required for support. Considerably greater attention will be given to the inspection of spare components for the jet engine. The former practice of "when in doubt, reject," cannot be economically followed because of the high unit cost of jet engine components. Another factor that must be considered in the maintenance of the airplane is the fact that its systems are extensively interrelated, making trouble-shooting much more difficult. In fact, consideration has been given to the training of maintenance trouble-shooting

technicians, to locate trouble so that correction may be rapidly accomplished.

Minimizing foreign object damage

In considering runway and taxiway requirements, it has been found that the term "good housekeeping" has assumed an entirely new and extremely important meaning. Military experience has proven that damage to jet engines due to the ingestion of foreign objects can be severe and costly. In fact, the U.S. Air Force believes that, as a rule, foreign object damage will lead all other causes of jet engine irregular removal. Two means are provided to minimize this problem. In the first place, the DC-8 airplane will be equipped with a high velocity air screen in the engine inlets. Tests have indicated that this screen will effectively break up the vortex motion below the air inlet and substantially decrease the possibility of the inlet suction drawing up foreign objects from the runway surface.

The second means of avoiding foreign object damage lies in the construction and maintenance of runways and taxiways. United Air Lines is requesting that taxiways be 125 ft in overall width. Of this width, 75 ft must be load-bearing, with 25 ft on either side of the load-bearing portion paved to minimize the accumulation of loose gravel and miscellaneous debris. In developing maintenance procedures for runways and taxiways, it will be imperative that equipment capable of thorough and rapid cleaning be provided. These procedures must insure that cleaning is accomplished on a routine basis and that all steps will be taken to keep runway and taxiway surfaces as free as possible of all types of foreign objects.

Loading charts

As previously mentioned, the rapid boarding of passengers is essential. However, many jet transports will probably be operated in a two-class configuration. This greatly complicates the development of loading charts for these airplanes. If current procedures were employed, the chart would be extremely difficult to use and greatly restrict the seating; it will probably be necessary to resort to the index system. This system of developing a chart requires three charts, actually; the first one establishing the index number for the various totals of coach and first class passengers, the second determining the maximum load, and the third the minimum load. Attention must be given to the development of these charts to insure that the traditional airline requirement of unrestricted seating be maintained in both the first class and coach sections of the airplane.

Noise reduction

Perhaps the most delicate, if not the most important, requirement of flight operating procedures concerns the matter of airport neighbor relations. It is essential to consider minimizing the effects of noise in the airport area. Even though the jet transport incorporates sound suppressors, it is believed that operating procedures can go a long way toward further reducing this problem. In numerous airports, measures have already been instituted to reduce the noise of present-day aircraft. This is accomplished by the use of preferential runways as well as maintaining takeoff power for the two full minutes allowed. In the case of the jet, procedures will be established for preferential runways and climbing as rapidly as possible in order to achieve the maximum vertical distance between the airplane and ground in a minimum time. This entire area is being closely studied and whatever operating procedures can be adopted to alleviate the noise problem will most certainly be exploited.

AIR TRAFFIC CONTROL

Another area receiving considerable study at this time is that of air traffic control. It appears that in each direction there will only be three altitudes available if the present 4,000 ft separation is maintained – 31,000, 35,000, 39,000, and in the opposite direction 29,000, 33,000 and 37,000 ft. The least of these altitudes is likely to be uneconomical and it may not be possible for a heavily loaded transport on a warm day to reach the upper altitudes. Therefore, there will be great demand to obtain clearances in the middle altitude band.

TRAINING OF PERSONNEL

Throughout the development of the airplane specification, training personnel have been closely following all developments. In the case of United Air Lines, it is anticipated that a Link Simulator will be available nine months before scheduled service. In addition, it is planned to use electronic engine simulators to facilitate teaching and instruction in the area of engine troubleshooting. The use of these simulators does not, of course, comprise all of the training being given the flight crews or the mechanics. They are used to prepare the personnel so that the training using actual equipment will be more effective.

A great deal of planning has already been expended in developing the master training program for the introduction of the jet aircraft. It is the United Air Lines' opinion that it is more desirable to have personnel trained by its company instructors rather than to send large numbers to the aircraft manufacturer and the various equipment vendors. The planning of the training program is a delicate project; if the training is conducted too far ahead of the inauguration of services, a large portion of it will not be retained. Every effort is being made to accomplish the training as close to the start of the inauguration of service as practicable.

CONCLUSION

It has not been the aim of this paper to outline the problems and to offer solutions for the work necessary to be accomplished prior to the introduction of jet transports. The aim has been to outline the potential problem areas and the way solutions are being approached by one airline.

The final proof of the effectiveness of this planning for the introduction of jet aircraft is yet to come; however, its outcome will be there for all to see, both other airlines and the airline customers. If the planning and its implementation have been successful, the turbine aircraft age will be ushered in smoothly and efficiently. If it has not been done to the proper degree of thoroughness, the failure will be obvious for all to see. But we are confident that we are on the right track. We are confident that realistic planning and the vigorous execution of that planning will enable us to usher in our Jet Age with memorable success.

JET WEATHER†

by P. D. McTaggart-Cowan*

Department of Transport

THE title, "Jet Weather", was chosen not to indicate that the following is an erudite discussion of the weather conditions as associated with the jet stream, but is used in the symbolic sense—the term "jet" to indicate the current nature of the problems to be discussed, and the term "weather" to indicate that the remarks, observations and conclusions herein presented are as seen through the eyes of a meteorologist and, therefore, may have a bias with regard to the importance attached to meteorology. Failure to mention associated problems in related fields is not intended to imply their secondary importance, nor to imply that meteorologists are unaware of their existence; but is the result of the writer's attempt to stay within the field in which he can claim some small measure of competence.

Meteorology, in common with the other services supporting aviation, has, must and will continue to go through a rapid evolution as it strives to meet the ever-changing requirements of the aviation industry. This paper will refer specifically to certain problems facing the Meteorological Service today in:

(a) dispatch control,
(b) very long range flights, and
(c) commercial jet aircraft operations.

Mention will also be made of the latest additions to our knowledge regarding the meteorology of jet streams. They appear important both in VLR flights and jet aircraft operations.

DISPATCH CONTROL

This term is used herein to connote those airline functions connected with immediate pre-flight planning, and flight watch from takeoff until landing.

The problem of dispatch control involves four units:

(i) the crew of the aircraft,
(ii) the meteorological office,
(iii) the company operations officer or dispatcher, and
(iv) the Air Traffic Control office.

Each has a specific field in which his knowledge will be greater than that of the other three, and the essential features of the knowledge of all four must be pooled for maximum safety, efficiency and economy of flight operations. From the meteorological standpoint, therefore, the problem is what, and how much, should the meteorologist contribute to this pool—what, and how much, must be received from the pool—and how this intelligence can be communicated (Figure 1).

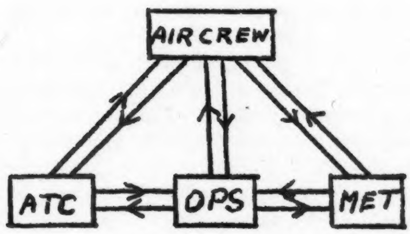


Figure 1

There is no question but that the meteorologist, because of his specialization, must provide the meteorological data and advice necessary for flight planning and to support the various phases of airborne operations; and this knowledge must be communicated to the aircrew and/or the dispatchers. The little idiom "and/or" is where the problem lies and its solution determines what information must flow back from the pilot and the dispatcher to the meteorologist.

During the pre-war development of transoceanic flying, the meteorologists participated actively in practically all facets of what later became known as the duties of the dispatchers. Each long over-ocean flight was a special event; the capabilities of the aircraft and its operation were known in considerable detail to the meteorologist. Briefings were prepared with the individual aircraft and crew in mind and the aircraft was followed minute by minute by the meteorologists as the flight progressed. The need, therefore, to differentiate between the respective responsibilities of the dispatcher and the meteorologist did not arise. The workload in the offices was light and the pioneer instinct drew the three groups together, so that there was such a high level of common understanding that the problem of the communication of this intelligence did not arise, nor, in fact, did it need specific formulation.

During the war the pilot, operations officer and meteorologist were all, so to speak, members of the same team—all overworked and each one helped the other to maximum extent, so that, again, the need for defining the exact spheres of operation of each did not arise; although,

†Paper read at the Joint I.A.S./C.A.I. Meeting in Montreal on the 21st October, 1957.

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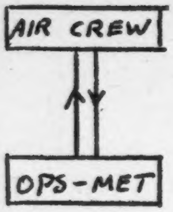
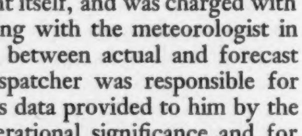


Figure 2
Pre-war and war

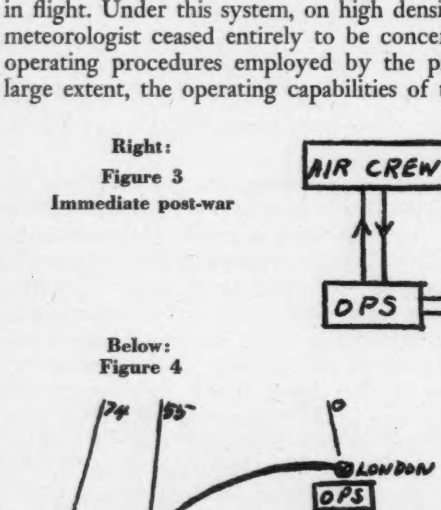
in the latter stages of the war, the problems to be faced immediately thereafter were recognized and documented (Figure 2).

In the immediate post-war period, the airline companies largely clarified the situation by announcing their intention to maintain dispatch offices at each end of all principal routes and at each major stopping point in between. They enjoined the Meteorological Services to establish meteorological offices immediately adjoining the dispatch offices, so that communication could be by word of mouth between the two teams (Figures 3 and 4). This presented a very simple and happy solution. It determined the number of principal forecast offices required and, at least as far as Canada was concerned, permitted a clear division of responsibilities. It was the duty of the meteorologist to provide the dispatcher and aircrew with all the meteorological information necessary for pre-flight planning, and to provide the pre-flight briefing of the pilot. During the progress of the flight, the meteorologist was to advise the dispatcher of all changes in the weather from the picture presented at the pre-flight briefing. At the same time the dispatcher was provided with current data so that he could monitor the progress of the forecast against the actual weather, and the flight itself, and was charged with the responsibility of checking with the meteorologist in the event that a difference between actual and forecast weather appeared. The dispatcher was responsible for deciding what of the various data provided to him by the forecast office were of operational significance and for having this selection of data transmitted to the aircraft in flight. Under this system, on high density routes, the meteorologist ceased entirely to be concerned with the operating procedures employed by the pilot and, to a large extent, the operating capabilities of the aircraft – apart from the basic knowledge of possible altitude and over-all range. The meteorologist was not concerned with the hour-by-hour progress of the flight. In other words, the meteorologist concentrated entirely on the meteorology of the situation. This was in marked contrast with the pre-war or wartime responsibilities, but it enabled each meteorologist to provide the maximum amount of meteorological service. The penalty, if in fact it can be called such, fell on the airline companies as they had to maintain a fairly elaborate network of dispatch offices along the main air routes of the world.

Right:
Figure 3
Immediate post-war



Below:
Figure 4



Over the past several years, with the gradual tightening of the economic situation in airline operations, there has been a steady trend among the airline companies to centralize dispatch control in a relatively small number of offices, not necessarily geographically connected with the air routes being operated; and the one-to-one correspondence between dispatch offices and participating meteorological offices is ceasing to exist. This reduces airline overhead and, if one distinguishes between managerial and flight-watch functions of dispatch, it probably enhances the efficiency of the managerial functions. However, from the flight-watch standpoint, it poses real problems, as there is not necessarily a dispatcher conveniently located near the meteorological office responsible for providing meteorological advice to the pilot (Figure 5). With the amount of meteorological information available and the heavy demands on radio communications of all sorts, it is necessary that there be some screening of meteorological information on the ground to determine what is necessary to be transmitted to the pilot, and what, while possibly interesting, is not necessary for the operation of the flight. In discussions under the aegis of ICAO, the trend has been to place this responsibility on the government services. If this is followed to its logical conclusion, it means that the meteorological forecast offices must get back into a portion of the dispatch field, acquire a knowledge of aircraft operating capabilities, and maintain a current knowledge of individual flight progress. ICAO documentation does not state the problem in quite such a clear fashion, but has in some way tended to obscure the exact problem by coining new terms. For example, one of the last ICAO conferences dealing with this matter invented the term "SIGMET", being an abbreviation of significant weather and defined as:

> "Information regarding the occurrence or expected occurrence in an area over which area-meteorological watch is being maintained of one or more of the following phenomena: active thunderstorm area, heavy hail, severe turbulence, severe icing, violent winds aloft, violent line squalls, sandstorms and duststorms."

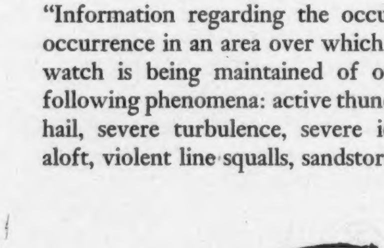


Figure 5

Previously the meteorological conditions now defined as "SIGMET" were characterized as warning messages or operationally significant weather. As long as the decision on whether to send a particular piece of weather information to the aircraft rested with the company dispatcher, the significance of the meteorological advice, or otherwise, could be determined by a man with a full knowledge of the capabilities of the aircraft and crew. With the dispatcher removed, someone else must make this decision; otherwise all available radio frequencies would be flooded with meteorological information, and there would be an extra crew man on each aircraft to sort it out on the flight deck. Obviously, this latter situation would not be countenanced. The meteorologist must, therefore, make the decision (Figure 6). For example, regardless of what trade name might be invented, there is no precise objective way of defining severe turbulence, severe icing, or an active thunderstorm area, without a direct knowledge of the aircraft and the flight plan and progress of the individual aircraft. An area of low level thunderstorms that would be of vital importance to a DC-4, operating at 10,000 ft under certain conditions, might be of no concern at all to a DC-8, a Boeing 707, or a Comet. Conversely, a jet stream at 35,000 to 40,000 ft of some 300 kts would be of very vital concern to these latter aircraft, whereas using air time to send the latest information on this jet stream to a DC-4 at 10,000 ft would cause nothing more than annoyance and frustration in the cockpit. The problem, therefore, that must be faced is—who is going to decide what should be sent to the aircraft? Then we must ensure that before the immediate post-war system decays any farther the responsibility is clearly recognized, designated, and accepted; otherwise, the pilot will be left with a substandard ground service as far as meteorology is concerned.

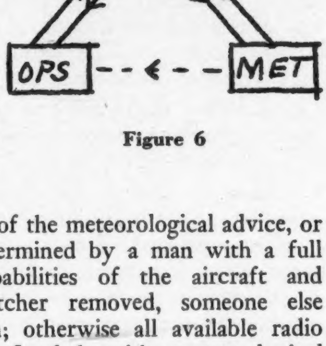


Figure 6

There are other aspects, but perhaps the foregoing example is sufficient to indicate the problem. The time has come when no one can afford to play ostrich on this problem any longer, and the coining of any more trade names should not be allowed to disguise the real features of this problem.

One solution would be for the airlines to establish joint flight-watch offices at those locations where separate dispatch offices were previously in operation.

VLR FLIGHTS

The advent of aircraft with substantially longer range than those that have been in operation over the past ten years is presenting special problems, both with respect to dispatch control and the provision of meteorological service in general. The Britannia and other aircraft, now coming into service, are capable of flying non-stop from the west coast of North America to Europe on the so-called polar routes. This represents roughly a flight through 130° of longitude—more than one-third of the way around the world and passing through areas where communications are difficult and installations are expensive to maintain. With the policy of remotely located dispatch offices, airlines are, quite naturally, desirous of performing the dispatch control functions of these flights from offices currently located well away from the actual flight path (Figure 7). If meteorological service is to be provided for these dispatch offices, it will mean that meteorological offices, in no way connected with the provision of meteorological service in the area of actual flight operations, are required to maintain a current knowledge of aviation weather in those areas because of their co-location with company dispatch offices. In other words, it would be quite possible to have a situation where three or four different forecast offices were all having to maintain a current state of knowledge over the air route, in addition to the two or three forecast offices in whose territory the flight actually took place. Any economy to the airlines company, therefore, is achieved, at least to some extent, at extra cost to the governments by a duplication of meteorological services. Perhaps the solution here is to separate the managerial functions from the flight-watch functions, and to hope that the airlines will agree that the flight-watch functions of dispatch control can be shared, so that joint flight-watch offices can be established on the air routes they serve and staffed jointly by the various airline companies, thus reducing the overhead costs (Figure 8).

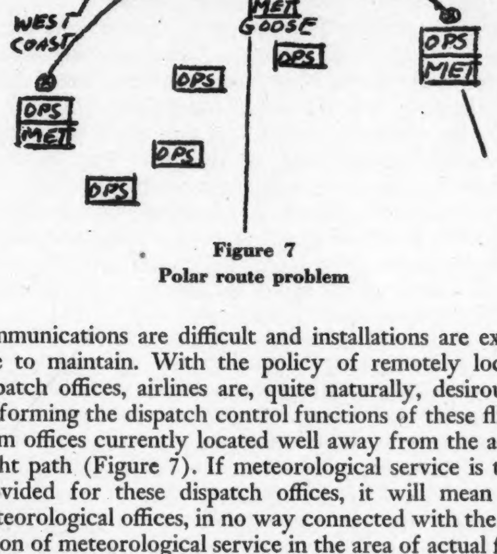


Figure 7
Polar route problem

There is an additional problem—that of communicating to the point of departure the meterological intelligence necessary to do the briefing for the aircraft. For example, in the pre-war era for Atlantic flights, all the detailed knowledge of Atlantic meteorology was focused at Foynes in Ireland and Botwood in Newfoundland; and, as all

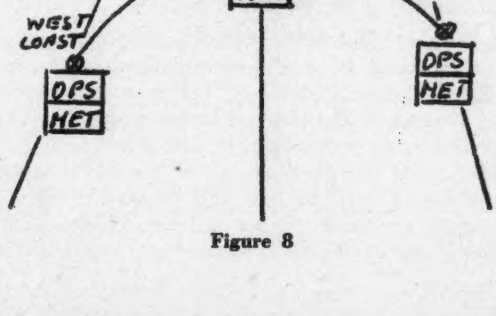


Figure 8

aircraft took off from and landed at these two places, this was entirely sufficient. During the war, it was necessary to stretch this intelligence back into the Montreal-Presque Isle area, and into the United Kingdom.

This penetration in depth served for the next decade, where non-stop flights across the Atlantic did not originate west of the Montreal-New York boundary line in North America, or in general, east of the Amsterdam-Paris line in Europe. Now, however, we are faced with flights originating almost twice the distance west in North America and there is a real communication problem to be solved. This will require a reappraisal with the airline companies of the minimum amount of data necessary to conduct the pre-flight planning phase successfully and to ensure a safe dispatch; and of the extent to which one can rely on ground-to-air communications to add to this minimum amount of data en route, so that the pilot at all times has the necessary meteorological information. This is a problem that will have to be faced by both the government Meteorological Services and the airlines, under the aegis of ICAO and WMO, in the immediate future. It would be entirely uneconomical to provide communication to transmit, for example, hourly reports from Greenland, Iceland, the United Kingdom and Baffin Island over to the west coast of North America, many flying hours away.

COMMERCIAL JET AIRCRAFT OPERATIONS

The introduction of large commercial jet aircraft on the major air routes of the world will present, as has been the case with each new type of aircraft in the past, new demands on the Meteorological Services. In the past, the aircraft operators have made a major contribution to the Meteorological Services of the world by being specific, and one might say demanding, in their requests for meteorological service. It appears that in connection with the introduction of jet aircraft there is some danger of the necessary meteorological support being taken for granted. This is, of course, an over-simplified generalization. One is led, on the one hand, to believe that the efficient operation of turbine engined aircraft will require a substantial increase in the accuracy of forecasting runway temperatures, upper air temperatures, the position and speed of the axes of jet streams etc, and yet, on the other hand, quantitative statements of the accuracy desired and the penalty per cent that efforts falling below this desirable accuracy will entail are not available. For example, in the recent Jet Operational Requirements Panel report from ICAO, we see the statement:

> "Although for the reasons indicated above the achievement of a high degree of accuracy in upper wind forecasting is highly desirable, the Panel was unable, on the basis of the information available to it, to specify quantitatively the degree of accuracy required."

To support high level aircraft operations, meteorological observations become quite expensive and their transmission and analysis laborious. The cost of meteorology to the citizens of all countries has been rising steadily as the demands for meteorological service increase. Paralleling this, with the development of numerical means of meteorological map analysis and prognosis, there have been some objective studies on the relative accuracy obtainable from forecasts at the present time. Two results announced on the basis of work done by Colonel Thompson of the USAF indicate that:

(a) the average percentage of error in a series of forecasts will be reduced by 2% for each hour that can be cut from the average communications time required to collect the weather observations needed to prepare the weather maps on which the forecasts are based, and

(b) doubling the density of the network of upper air stations would decrease the average percentage of error in a series of forecasts by 10%.

What is needed, therefore, from the companies planning jet aircraft operations, is a statement of the accuracy required of each primary meteorological element which is essential to provide a safe operation and necessary to permit the aircraft to be operated in such a manner that the expected revenue would just balance the cost of operation. A separate statement of the effect on the economy and efficiency of operation for each per cent increase in accuracy above this minimum acceptable figure would also be required. It is appreciated that this information would have to be presented in a statistical manner, because on neither side of the ledger are we dealing with absolute quantities. Nevertheless, a study of this sort would aid inestimably in presenting to those responsible a picture of whether or not substantial expansion of upper air networks can be justified, whether or not the expansion or improvement of communications systems to reduce communication delays can be supported etc, etc.

The absence of such statements from the airline companies in the past may perhaps have contributed to the steady reduction in the number of Ocean Weather Ships in the world. The work of Colonel Thompson gives us at least a first order approximation of the effects of such reduction. His work will, I am sure, be further refined, but in order to assess it in terms of operating consequences parallel data from the airline companies are certainly needed.

Such an exchange of scientific information need not in any way enter into, or initiate, discussions on user charges. Such a possibility may, in the past, have curtailed exchange of this type of information. However, matters of that sort are discussed on an entirely different plane from the scientific exchange of information here recommended as essential for meteorological services, if they are to adequately prepare their staffs, their communications systems and their networks for the introduction of commercial jet aircraft. It is not intended to leave you with the impression that meteorologists are unable at the moment to provide the bare essentials. The body of experience with somewhat similar military aircraft has given meteorologists the necessary experience. What remains to be determined is whether the accuracy is such as to make the operation economical, without substantial increases in observations and communications.

In the case of jet aircraft operations, the problem raised earlier in this paper of the communications between the meteorologist, the dispatcher and the pilot becomes still more critical. If, in fact, the airline companies will establish flight-watch offices at the geographically convenient locations serving each main route, the matter becomes largely one of communications, because experience has shown that the meteorologist and the dispatcher, if located side by side, can exchange information

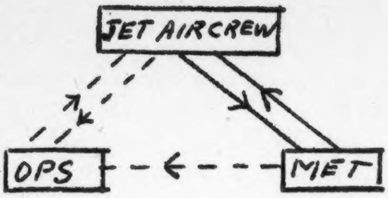


Figure 9

with the necessary rapidity. If they are separated, there would appear to be no alternative but to have the meteorological data flow directly from the forecaster to the pilot, with the meteorologist making operational decisions, as the time penalty involved in communicating it to a third physical location would be too severe (Figure 9).

In the transmission of meteorological data to aircraft, it is encouraging to note the pioneer work going on, spearheaded by T.C.A. and B.O.A.C., in airborne radioteletype. It is hoped that, looking perhaps a little farther ahead, experiments would soon begin on airborne facsimile as a means for transmitting from the ground to the air the necessary meteorological intelligence, thus substantially freeing the voice communications for traffic control and last-minute landing weather advice. This would also eliminate once and for all phonetic and transliteration errors in communications.

JET STREAM

Finally, it is desired to touch very briefly on some recent advances in knowledge of the jet stream. Much has been said of the advantages of jet stream navigation in long range operations. There have been excellent special studies, such as the research work done by Pan American Airways in their U.S. Navy sponsored contract in the Pacific. Much of the earlier writings on jet stream navigation gave an over-simplified picture of the jet stream pattern in the troposphere, particularly in the northern hemisphere. Most of the pictures showed a single jet stream wandering across North America, the North Atlantic and Europe, which an aircraft could conveniently follow going eastwards and avoid coming westbound.

A recent paper published by Dr. McIntyre, and presented to the U.G.G.I. meetings in Toronto last month, has established the existence, for a substantial portion of the time, of no fewer than three jet streams in the troposphere: one in the Arctic, one in mid-latitudes and one in lower latitudes, although their positions and directions are subject to substantial day-to-day changes. Recent work done by Professor Reed, of the University of Washington in Seattle, has shown that across longitudes 80°W and 20°E a single jet maximum exists for only some 10% of the total time, with 2, 3, or even 4 jet maxima existing for 90% of the time. This will complicate the meteorologist's job and also the navigator's job and adds further emphasis to the need for studying the operational penalties of inaccuracies in wind forecasts due to paucity of upper air data. It may be that our current capability is adequate, but until a study is made this cannot be stated categorically.

And, finally, to allay any false optimism that when the present large jet transports are superseded by even larger super jet transports, flying high in the stratosphere, the jet stream will become an item of academic interest only, I would like to draw attention to the recent researches by Dr. Godson and others which have shown the existence of a high-altitude stratospheric jet with wind speeds of up to 200 kts.

Flight Testing in the Space Age

(See pages 126 to 130)

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FLIGHT TESTING IN THE SPACE AGE†

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SUMMARY

The Space Age is upon us and, before long, a man will put himself into orbit around the Earth as a giant step towards more ambitious travel. Flight testing for this eventuality is going to present some unique problems in instrumentation, communications and real estate. These, plus the economics of the program, will dictate that, more and more, actual flights in space development programs are going to be supplanted by investigations in laboratory devices, such as the simulator and centrifuge. Nevertheless, the ultimate proof of any such system or components thereof will hinge on successful manned flight. Man appears to be as capable of adapting himself to the rigors of space travel as he is to the hazards of city traffic; more so, it appears, than is present-day electronic equipment. Therefore, the best bet for the earliest manned satellite is the design which utilizes to the limit that incomparable computer-servomechanism – man himself.

INTRODUCTION

WHEREAS the Stone Age lasted for untold thousands of years, the Bronze Age was of measurable centuries and subsequent eras have been progressively shorter lived. No better proof of this exponential nature of man's scientific progress can be found than in the imminent passing of the Air Age, barely half a century old. A few months ago, there were many who would have us believe in the dawn of a Missile Age. Whether because of their commissars' coercion or a dogged determination, the scientists of Russia have attended to the demise of this missile makers' dream and have disempedestalled the ballistic device from its Greek-fire-like "ultimate weapon" role. For the "little moons" have so awakened man to the pace of his progress that today the ballistic missile promises to fill an important, but hardly all-encompassing, place in the arsenals of the world. Indeed, before its perfection, we may see it pass into obsolescence, outmoded by man's conquest of space. For it is this infinite region beyond the earth's atmosphere that in the near future will begin to feed our insatiable hunger for greater challenge and new horizons – this is the medium that will name the next era in the progress of civilization the Space Age. Although the actual beginning is yet ahead of us, it should be made clear that tomorrow's space explorer will no more yield his place to canines or automatons than would Hilary have been content to plant his flag on Everest with an artillery shell.

†Paper read at the Mid-season Meeting of the C.A.I. in Vancouver on the 27th February, 1958.

*Engineering Test Pilot.

LIMITATIONS OF AN UNMANNED SYSTEM

Before turning to the problems of bringing about transition to the Space Age, it might be well to review some limitations of the ballistic missile concept. This should serve the dual purpose of reassuring the pilot fraternity whose role in new weapons systems was, for a while, fast assuming an importance akin to the mule skinners' and of pointing out by analogy many reasons for building piloted as well as automated space vehicles.

Some of the inherent limitations of the ballistic missile are:

(1) *Inflexibility*

Once burnout has occurred, no change in target assignment can be made though, for a short period, cancellation may be possible by commanded destruction. (A manned bomber can be directed to any number of alternate targets.)

(2) *Immobility*

Requirement for complex launching sites coupled with size and weight of missiles themselves make dispersion both difficult and expensive. (A manned bomber supplies its own mobility, can be air dispersed, and can move to any field with adequate runways. Often it can transport its own support equipment.)

(3) *Reliability*

The complexity of multi-stage sequencing with a requirement for extreme accuracy will necessitate costly loss of many missiles to commanded self-destruction by the range officer because of component failure or inadequate accuracy. (A manned bomber's crew can select standby systems without a need for failure-sensitive automatic switchover devices, can trouble-shoot in the air and in extreme emergency can usually manage safe return to base.)

(4) *Elaborate countdown*

A certain minimum pre-launch countdown will be required for a ballistic missile which could eliminate the advantage of its great speed. (An intercontinental, manned bomber force can keep a certain portion of its aircraft airborne and en route to targets continuously; fighter-bombers nearer potential enemy borders can be in a state of continuous alert. Much of the "countdown" for manned aircraft can be accomplished en route to the target.)

(5) *Difficult training procedures*

It is hard to visualize how ballistic missile crews are going to get in their target practice. This will either be

very expensive or unrealistic. (Manned bomber crews are required to maintain a high level of bombing proficiency through training in both radar simulated and actual drops.)

(6) *Imponderable maintenance procedures*

It's an old but valid axiom that if you want to keep an airplane in commission, fly it. Planes that stay on the ground too long are plagued with hydraulic seals that dry up, relay points that corrode, valves that get sticky and general field maintenance degradation from dust and disuse. This will be a major factor in missile reliability at the operational level. Static thrust stands can be supplied at considerable expense. But how can second and subsequent stages be fully checked? Functional flights of ballistic missiles do not seem to supply the answer. (Manned aircraft can be given functional flights as often as maintenance reliability standards dictate.)

(7) *No recall*

In order not to give the enemy a simple countermeasure device, the ability to destroy the missile must also be denied the launch team once the proper track to the target is established. Thus it is imperative that whoever pushes the button be absolutely sure of his game lest a nuclear war be touched off by an errant missile-like meteor. (Last-minute recall capability of a manned bomber is, of course, a design requirement.)

(8) *Prescribed trajectory*

The limited cone through which a ballistic missile must pass in going from A to B greatly simplifies the enemy's problems of search, detection and anti-missile measures. (The manned bomber can approach from any quadrant at high or low altitude and can feint at unwanted targets to further confound enemy defenses.)

(9) *Limited application*

Philosophically, the ballistic missile concept is a dead end; its development leads to itself alone. One hears little talk of the peacetime uses of the ballistic missile. (With manned weapons systems, there are concurrent reconnaissance, surveillance and commercial cargo and passenger carrying capabilities. In addition to these, with manned space vehicles, there is achieved a manifold expansion of man's understanding of his universe.)

Much of what is noted above with regard to the adequacy of an all-missile arsenal was earlier stated in a pre-Sputnik memorandum written by Dr. Allen E. Puckett to the National Academy of Sciences Staff[1]. In light of increased space consciousness, these problems merit review and constant scrutiny. For the present, however, it may be said that, just as mechanized stability and control assistance to the pilot of high performance aircraft has become mandatory[2], it is becoming equally clear that man's intelligence, judgment and compact computer dimensions must be integrated into any system that is to achieve maximum exploitation of our fast growing space potential.

MANNED SPACE FLIGHT

The Vehicle

In order to obtain a clearer picture of the flight test problems associated with a space venture, let us assume that we are going to develop a one-tenth scale version of von Braun's passenger-carrying orbital ferry vehicle designed for the Mars Project[3]. Design parameters and performance estimates were taken from von Braun's book and scaled down to obtain a more realistic article for an initial space venture. After a final maneuver of adjustment, the third stage of this satellite system, a piloted vehicle weighing 13,000 pounds at burnout, should find itself in a circular orbit 935 nautical miles above the surface of the earth. However, prior to achieving this ultimate performance trip, long months of preliminary testing will have transpired, not to mention a year or so of detail design and fabrication work before that. Only the testing phase will be considered here, particularly as it is concerned with the integration of the human pilot into the system.

The Program

The test program should be run in four phases, with Phases I and II being conducted concurrently with Phase III.

Phase I

The third stage of this satellite system should be designed as a complete aircraft capable of being borne aloft and launched by a mother ship in much the same manner as were the X-1 and X-2 research aircraft. Phase I would consist of fully developing the performance envelope of this third stage. Glide flights would be conducted first to check low speed handling qualities and landing characteristics. Powered flights would investigate supersonic and hypersonic flight and a start can be made toward defining the problem of re-entry into the earth's atmosphere. As the envelope of this third stage is developed, much attention will have to be given to adequacy and proper utilization of controls, optimization of three-axis damper systems and heating. The temperature problem should be measured first in level flight and then, as trajectory peaks are raised, heat as a factor in the re-entry problem must be investigated.

Phase II

This portion of the program would consist of marrying the second and third stages of the satellite system. The second stage would not be manned, but recovery devices in the form of parachutes and Titan-sized water wings are worthy of study from the economy viewpoint. Though presently envisioned as powered by liquid propellant rocket engines, the development of solid propellants should be closely monitored for application to a production version of the second stage for the attendant gain in reliability, operational simplicity and economy. Before making any piloted flights, second stage boosters should be fitted with dummy counterparts of the third stage and sufficient launches made to prove the second stage stability, control programming and performance. Initial piloted tests of this combination ought to be done employing considerably less than maximum burning time of the second stage booster; thus, in the test development program, the flexibility of the liquid propellant rocket engine is desirable for the second stage. The increased performance of this two-stage system should give a much clearer picture of the re-entry phase.

Phase III

In the third phase of the flight test program, the first stage vehicle would be flown. These tests should be

conducted concurrently with those of Phases I and II. Though not so envisioned by von Braun, the vertical takeoff, liquid rocket powered first stage of the system might be designed as a piloted device. After expending its rocket propellant, it would then be capable of executing a conventional landing with the aid of aerodynamic lift and a pair of auxiliary turbojet engines. Having the first stage a recoverable item gives the added asset of self-mobility in moving the large, cumbersome first stage about and is economically attractive in an all-out space effort. Initial flights should be at light weights with reduced power, achieving perhaps 40,000 ft altitude at burnout. These tests would prove basic control elements of the first stage and its low speed handling and landing characteristics using the turbojets. Since the first stage would coast to an altitude of nearly 300,000 ft in the course of the actual satellite launch, something of a re-entry problem will be involved in returning to the denser regions; thus gradual build-up to the complete system launch conditions must be made. Finally, with dummy shapes to simulate second and third stage mass and drag, the first stage must demonstrate its ability to accelerate its payload to the required attitude, altitude, and velocity. Since the first stage trajectory covers a horizontal range of only 180 miles, its auxiliary engines would permit return to the launch site. Therefore, a fixed base of operations can be used for this phase.

Phase IV

Obviously, Phase IV would be involved with putting our man and his vehicle into orbit. With Phases I, II and III satisfactorily accomplished, there seems little left to be done except get on with it as far as the hardware of our project is concerned. First, however, some less than maximum performance flights of the complete three-stage system might prove desirable for a more conservative approach to the sustained orbit. These build-up flights would be of the long range, boost-glide variety and would serve the purpose of developing navigational methods, checking ground monitor and tracking devices and further optimizing re-entry techniques. In establishing bases for this part of the program, real estate problems of a global nature will be involved.

In the first orbital effort, the third stage at burnout would have sufficient velocity in excess of that required for a circular orbit at the burnout altitude of 53 nautical miles, to coast out to an apogee of 935 miles above the Earth's surface. At that point, the rocket engine could be relighted to add a velocity increment of 1,500 ft/sec to put the vehicle into a circular orbit. However, in the initial try, it would probably be just as well to hold to the elliptical orbit. By so doing on approaching the perigee of 53 miles, the re-entry maneuver will be automatically initiated since the vehicle begins to encounter enough atmosphere for a significant deceleration at an altitude of approximately 70 miles. Thus, depending on the re-entry technique, the vehicle will accomplish one and a half to two circuits of the Earth on its first orbital journey. Using this technique for the first try has several advantages – re-entry does not depend on the satisfactory firing of the rocket engine; however, if the engine is functioning properly, the fuel normally intended for establishing the large circular orbit and

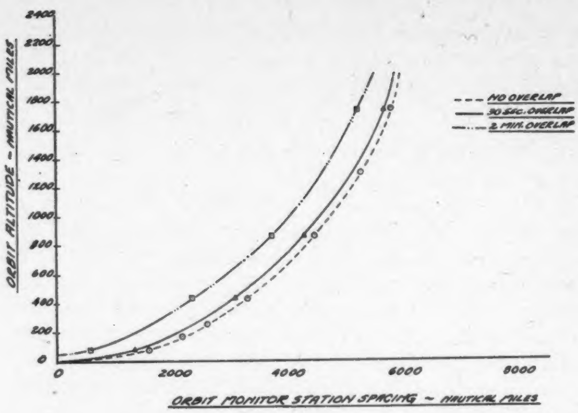


Figure 1
Tracking and communication monitor station spacing as a function of orbit altitude

upsetting this orbit for re-entry can be used for corrections to heading as required and for adjusting or aborting re-entry should either appear necessary. As the test program continues, variations in burnout velocity of the third stage and the maneuver of adjustment at the apogee can yield a large variety of orbit geometries. Optimum orbit geometry will, of course, depend on the nature of the mission. For mapping, reconnaissance or surveillance, a low altitude circular orbit appears desirable – say 90 miles. However, on inspection of Figure 1, it is seen that, if contiguous coverage of the satellite in a 90-mile orbit is desired, monitor stations must be placed every 1,450 miles, for a station overlap of 30 seconds. For a more realistic overlap of two minutes, monitor stations must be placed every 650 miles. In the initial test program, therefore, an elliptical orbit with apogee of nearly 1,000 miles is fairly ideal. This would increase monitor station spacing to 4,000 miles on the other side of the world where it might be difficult to find friendly real estate, although from this high altitude, observation of such tourist attractions as industrial centers, airfields and missile launching pads might be difficult.

The Pilot

Having put a moon out into orbit and brought it home again, it might be well to see how the driver fared. How did he prepare for his adventure, how respond to his strange environment?

Preparation

From the initial conception of a manned moon, the pilot must be intimately involved. Let him delay too long in joining the initial design phase and his craft will have been automated sufficiently to relegate its occupant to a human guinea pig, along for the study of cosmic radiation effects or ennui at zero "g", a stunt rider contributing only biological interest. For the dignity of man in general and of the pilot breed in particular, this pilot must prove his worth not just in terms of the weight of computers, servos, amplifiers and actuators he can replace. More positively, he must show that no degree of redundancy can replace his reliability, no array of transducers can match his perception, nor can

IBM's whole inventory of computers supplant his judgment. He will accomplish these things by insisting on an instrument display that will tell him trends as well as failures — and yet a display he can scan in an instant when all goes well. He must satisfy himself that fail-safe design is truly fail-safe and not just fail-centered. He will see to it that he can monitor all automatic devices over which he has some control and he will fight all automaticity that smacks of "gilding the lily". For example, should it prove desirable to program the pitch attitude of the first stage, the pilot of that stage must be able to monitor and overpower this attitude control in case of improper performance of the automatic device. In the course of the test program, the pilot will be in a position to salvage many millions of dollars worth of equipment. Once launched in his orbit, he can make necessary corrections to orbit geometry by adjustment of its eccentricity. In the final analysis, he will be in a position to perceive and record information in a single flight that a thousand Sputniks could not assimilate and beam home with beeping in a year — such things, perhaps, as an extra-atmospheric spectograph of Venus, a new slant on the aurora and the psychological impact of hanging an hour or so weightless, pondering if his engine will fire for the re-entry maneuver. These are among the reasons for his being there, and on his judgment of re-entry depends the return of this information to his sponsors, not to mention his own survival.

In the early design stages, the most useful tool for integrating the pilot's transfer function into the system loop is the simulator. Provided that adequate banks of digital and analog computers are available, the entire test program can be flown first in the laboratory. Initially, all system components except the pilot and the cockpit are represented by electrical analogs. As components are developed, the actual pieces of hardware replace their electrical counterparts until, finally, the computers are needed only for the overall inertia and space geometry of the system and, of course, for aerodynamics in those portions of the flight where the atmosphere is a factor. From the simulator there will be gained:

(1) Information on the initial design parameters for system components.
(2) Optimization of control loop gains with actual hardware.
(3) Optimization of pilot's attitude and performance presentations.
(4) Pilot familiarization with the effects of large changes in stability characteristics that accompany rapid accelerations in the atmosphere.
(5) Pilot familiarization with use of reaction devices for extra-atmospheric attitude control.
(6) Optimization of re-entry techniques.
(7) Determination of emergency procedures.

Physiological Limitations

For a long time, much doubt was voiced as to whether man's apparently fragile framework would adapt itself to the rigors of space travel. At best, it was thought that he must be securely restrained and put

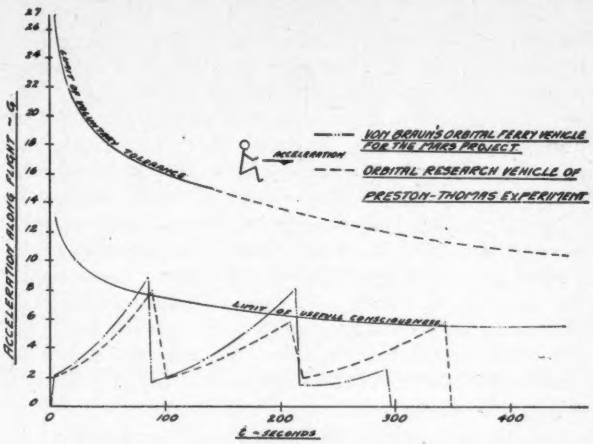


Figure 2
Human tolerance to acceleration as compared with accelerations along flight path of three orbital vehicles

under strong sedatives. Thanks to much spectacular work done by Air Force volunteers and a number of inadvertent heroes, it has been demonstrated that the human species is a tough mechanism. Among the principal physiological problem areas for the first satellite venture are high longitudinal accelerations, weightlessness, temperature, boredom and radiation.

The problem of long duration acceleration of a satellite system in achieving its orbit is illustrated in Figure 2. Here are shown acceleration time histories of two possible orbital vehicles — Wernher von Braun's ferry satellite for the Mars Project[3] and a theoretical system used by Preston-Thomas in his acceleration studies[4]. On the same figure are shown two plots of man's tolerance to acceleration as assembled from the available literature by Hegenwald and Oishi[5]. The "limit of voluntary tolerance" is defined for the upper curve as "the area of human capacity within which applied accelerations can be expected to produce no worse than short periods of extreme discomfort or unconsciousness". The "limit of useful consciousness" is defined as "the boundary of awareness sufficient for proper response to stimuli which normally generate familiar, well-indoctrinated reactions". It should be noted that these tolerance curves are based on acceleration, acting on the subject from back to front, which is the optimum orientation from the standpoint of human "g" tolerance. Moreover, these acceleration tolerance curves do not represent a time history of man's maximum tolerance, but a plot of those periods of time for various unique values of "g" that a man can tolerate or under which he can retain useful consciousness. Thus, the fact that the satellite acceleration time histories cross the useful consciousness curve does not indicate that in this period of the maneuver the pilot will be blacked out. The Preston-Thomas curve is of particular interest, since this time history of longitudinal acceleration was duplicated on a centrifuge with nine different subjects making several simulated launches each. Throughout each launch, the individual was required to perform a simple tracking problem, correcting errors in both azimuth and elevation through normal movement of a control stick. None of

the subjects experienced blackout or severe discomfort of any kind and all were able to perform a creditable tracking job. Tracking performance was noted to improve significantly as experience at these high levels of transverse accelerations increased. For this reason, the final step in ground simulation for the first manned satellite should be performed with pilot and cockpit in a centrifuge, wherein a complete mission is flown with three-axis accelerations being added through mechanization of the centrifuge. Making the pilot at home under the abnormal accelerations of the satellite launch through the use of the centrifuge removes the surprise effect of the unusual in actual launches and will allow him to concentrate on the control problem and any emergencies which may arise.

At the termination of his high "g" experience, the space pioneer is faced with the opposite side of the coin – zero "g". There has been much speculation on this subject, but, since weightlessness cannot be simulated adequately in the laboratory, human experience at zero "g" for long periods is quite lacking. In today's high performance airplanes, zero "g" for periods approaching two minutes can be achieved. Two-place jet airplanes are being used now at the Wright Air Development Center for an investigation of the problem. Why two-place? – because the man flying the airplane is too busy controlling attitude and power in maintaining this condition to evaluate his reaction to it. Another variable in the effects of weightlessness is the degree of restraint employed. If seat belt and shoulder harness are loose, the feeling of floating around the cockpit is most uncomfortable. Though much is yet to be learned about long periods of weightlessness, there are two factors which should be of positive benefit in this regard:

(1) provide the pilot with snug (but flexible) physical restraint, and
(2) keep him busy.

Insofar as temperature is concerned, the heat that must be absorbed by the vehicle in the re-entry phase has decidedly roasting magnitudes, but this is no news to anyone who has watched meteors torch off in trying the same trick. The nature of temperature control for the re-entry maneuver is beyond the scope of this study. However, some limits on what the pilot will tolerate can be shown. Figure 3 illustrates the maximum duration of time a "well-motivated" man can effectively perform at various temperature levels with two types of protective clothing. The curves are conservative estimates made from actual tests, as reported by Vince Blockley[6]. The definition of "well-motivated" is not altogether clear, though it is difficult to imagine a stronger motivation than preserving one's self from imminent incineration. The conditions of low humidity, low barometric pressure (approximately 25,000 ft pres alt) and low air velocity must be maintained to achieve this level of tolerance. It is most interesting to note that a study of present-day airborne electronic equipment reveals that this equipment can be expected to operate at 200°F for no longer than between 3 and 13 minutes. In addition, while out in the orbit, there are indications[6] that dissipation of heat generated by electrical and electronic equipment may prove to be a problem. This allows another comparison to be drawn between man and the mechanized devices that would usurp his function. The average man will produce about 0.8 watts for each pound of his weight, whereas the heat produced by present day autopilots is between 3 and 4 watts per pound of such equipment.

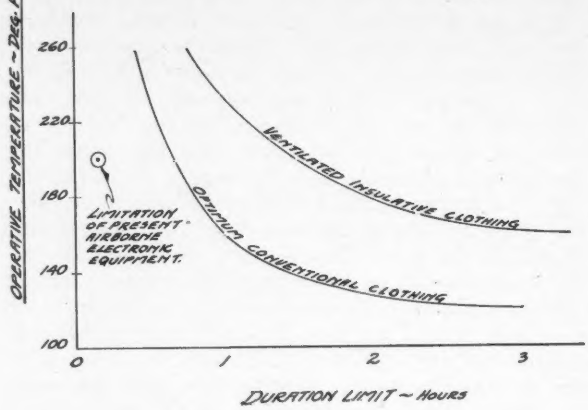


Figure 3

Thermal limits for man's proficient performance. Conditions: low humidity, low barometric pressure and low air velocity

Psychologists predict that space travel will be dull to the point of boredom – boredom that tends to lead to hallucinations, self-destructive tendencies or simply sound sleep. For the short three-hour sojourn in space under discussion here, the pilot probably will not be bored – a better guess, for the first flight at least, is that he will be very scared. Fortunately, the best therapy for either fear or ennui is to keep the subject importantly engaged. This means that, throughout the flight, the pilot should be closely occupied with certain duties, on his competent performance of which rests the success of the mission.

The complete nature of cosmic radiation outside the atmosphere is yet to be determined, though, from the satellite Explorer, indications are that this radiation is not of sufficient concentration to be dangerous to man. As time goes by, much more will be learned of this phenomenon; in fact, an important contribution of the Phase I and Phase II portions of the satellite program presented here would be to further define the magnitude of this problem.

In brief, there appears to be no physiological limitation which would prevent a normal, healthy man from contributing the full effectiveness of his inherent reliability, perception and judgment to the success of the first manned satellite – from launch to landing. However, his level of performance can be improved by making him completely at home under the acceleration schedules to be encountered through use of the centrifuge, by thoroughly acquainting him with the nature of the exit and re-entry using the simulator, by providing him with snug restraints and by keeping him importantly engaged throughout the flight.

For References see page 125

C.A.I. LOG

SECRETARY'S LETTER

MID-SEASON MEETING

THE Vancouver Branch certainly staged a very satisfactory Mid-season Meeting, as reported more fully on the following pages. The President and I floundered about all night in an Ottawa snow storm before we could get away, but eventually arrived in the spring sunshine on the coast, where I had to endure numerous jibes about my inappropriate snowboots.

On this occasion, we introduced a special evening session on the first day and held the Dinner at the conclusion of the meeting on the second day. It proved to be a good arrangement. It enabled us to fit in thirteen technical papers, all well attended, before we relaxed for the less serious part of the programme, and the evening session offered an opportunity for those who could not get away from work during the day to enjoy some of the technical fare.

Considering the distance and the prevailing restrictions on travelling, the attendance from over the mountains was better than I had expected. The hero of the occasion was LCDR J. C. Sloan, a Councillor for the Halifax-Dartmouth Branch, who flew from coast to coast in a Banshee. "The Navy is here."

A NEW BRANCH

On the day before the Mid-season Meeting opened, the Council met in Vancouver and introduced two new members to the C.A.I. family. One of these was the Calgary Branch.

Calgary has had a small group of members, mostly in the Provincial Institute of Technology and Art, since the earliest days of the C.A.I. but some difficulty has been experienced in raising their number to the requisite twenty. There has been a sharp upswing recently and the membership now stands at thirty-five. With the official establishment of a Branch, it will probably increase considerably. There is of course potential for a large number of Student members in the Provincial Institute and we hope that C.A.I. activities in the district will prove to be interesting and useful to them.

AND A NEW SECTION

The other new group to receive Council approval was the Propulsion Section. It is encouraging to see another Section taking its place beside the Test Pilots. The Test Pilots Section, which was formed in 1956, has been making steady progress but lone pioneering is always heavy going and the two Sections, learning from each other, should now develop more rapidly.

Incidentally, the Test Pilots sponsored a very good session at the Mid-season Meeting.

CASEY BALDWIN

In the last issue of the Journal, we paid a brief tribute to the 50th Anniversary of Casey Baldwin's historic flight in the Red Wing. In discussion with Mr. Parkin, I understand that there are good grounds for believing that Baldwin was the first British subject to fly, though the point is debatable. Perhaps I can arouse some of our historically minded readers in Great Britain to start the debate.

FIRST INTERNATIONAL CONGRESS

On the next page we give particulars of the preliminary arrangements for the First International Congress, to be held in Madrid in September. It should be noted that the dates of the Congress follow immediately after the dates of the S.B.A.C. Show at Farnborough (1st to 7th September) and it is hoped that several people from this country will find it convenient to attend both.

FIRST INTERNATIONAL CONGRESS OF THE AERONAUTICAL SCIENCES

Madrid, Spain: 8th-13th September, 1958

SINCE the fall of 1956 many countries have been cooperating in the organization of the International Council of the Aeronautical Sciences (I.C.A.S.). A provisional organization has been formed under the Presidency of Dr. Theodor von Kármán (U.S.A.), with M. Maurice Roy (France) as Chairman of the Executive Committee. The I.A.S. has been designated as the permanent Secretariat. Financial support will derive from the Daniel and Florence Guggenheim Memorial Fund.

To date 18 countries having organized technical societies are planning to participate in the First Congress of the I.C.A.S. to be held in Madrid from the 8th to the 13th September, 1958; these are Australia, Belgium, Canada, Denmark, France, Germany, Israel, Italy, Japan, New Zealand, Poland, Rumania, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. Participation by other countries is expected.

INFORMATION FOR DELEGATES

Canadian delegates wishing to attend this meeting should apply to the Secretary, C.A.I. for application forms and further information.

Viajes Marsans, Carrera de San Jeronimo, 19 Madrid, Spain, will handle room reservations and a special form will be sent to delegates by the Secretary. Delegates should make their own travel arrangements.

PROGRAMME

Approximately 40 papers have been selected for the tentative programme as follows:

September 8th

OPENING SESSION

Daniel and Florence Guggenheim International Memorial Lecture — TH. VON KÁRMÁN

Juan de la Cierva Lecture — P. BLANCO

September 9th

GENERAL SESSION

Aerodynamic Design for Supersonic Speeds—R. T. JONES (U.S.A.)

Telecommand and Navigation — W. H. STEPHENS (U.K.)

Propulsion Supersonics — M. ROY (France)

HYPERSONIC FLOW

Newtonian Flow Theory in Hypersonic Aerodynamics — W. D. HAYES (U.S.A.)

Dynamics of a Dissociating Gas — M. J. LIGHTHILL (U.K.)

STRUCTURES AND AEROELASTICITY

Papers by: A. VAN DER NEUT (Holland); L. BROGLIO (Italy); R. MAZET (France); and M. T. LANDAHL (Sweden)

September 10th

HEAT TRANSFER AND HEAT BARRIER

Mass Transfer Cooling, A Means to Protect High Speed Aircraft — E. R. G. ECKERT (U.S.A.)

The Heat Barrier and its Influence on Hypersonic Aerodynamics — R. J. MONAGHAN (U.K.)

Non Adiabatic Flow of a Gas in a Rotating Duct — M. DE SENDASORTA (Spain)

Two papers on Heat Transfer by: R. SIESTRUNCK and J. J. BERNARD (France); and E. SCHMIDT (Germany)

JET ENGINES AND NOISE

Papers by: F. B. GREATREX (U.K.); H. S. RIBNER, K. K. NEELY and B. ETKIN (Canada); W. LITTLEWOOD (U.S.A.); and H. LE BOITEUX (France)

NAVIGATION AND GUIDANCE

Some Considerations of Safety in Instrument Flight Control — A. M. A. MAJENDIE (U.K.)

On Dynamically Caused Drift Effects of Gyro-Systems — K. MAGNUS (Germany)

Inertial Navigation — C. S. DRAPER (U.S.A.)

BOUNDARY LAYER CONTROL

Papers by: H. SCHLICHTING (Germany); G. V. LACHMANN (U.K.); and M. P. CARRIERE, P. POISSON-QUINTON and E. A. EICHELBRENNER (France)

September 11th

GENERAL SESSION

Aeroelastic Problems of Aircraft Construction — H. G. KUSSNER (Germany)

A Review of Some Recent Developments in Hypersonic Flow — A. FERRI (U.S.A.)

September 12th

VTOL-STOL

Papers by: J. P. CAMPBELL (U.S.A.); D. KEITH-LUCAS (U.K.); and M. EGGERS (France)

HEAT RESISTANT MATERIALS

Materials and Structures for Finite Lifetime—N. J. HOFF (U.S.A.);

Problems in Heat Resistant Materials for High Speed Flight and Propulsion — P. DUWEZ (U.S.A.)

HUMAN ENGINEERING

Papers by: D. G. SIMONS (U.S.A.); G. MELVILLE JONES (U.K.); and M. E. EVRARD (Belgium)

TELECOMMAND AND TELEMETERING

Transmission of Data by Radio from the U.S. Satellites — J. T. MENGEL (U.S.A.)

September 13th

GENERAL SESSION

Propulsion Methods in Astronautics — W. BOLLAY (U.S.A.)

MID-SEASON MEETING

THE second Mid-season Meeting of the Institute was held in the Hotel Vancouver, Vancouver, on the 27th and 28th February, 1958. The programme included five technical sessions and a Dinner, held in the evening of the second day. A novel feature, so far as Institute meetings are concerned, was a technical session held in the evening of the first day, so timed to enable members of the Vancouver Branch who were unable to get away from their work during the daytime to attend at least a part of the technical activities.

In spite of the distance from the Institute's centre of gravity and existing restrictions on travel, both financial and meteorological (there was heavy snow "down east") the attendance was satisfactory, 145 registering for the technical session, of which 46 came from outside the Vancouver area. The attendance at the Dinner was 151 – this was perhaps a little disappointing.

Mr. H. H. Ollis, Chairman of the Vancouver Branch, opened the meeting on the Thursday morning with a brief address of welcome. He mentioned that 1958 happened to be the B.C. Centennial and observed that it was therefore most fitting that the Institute should select Vancouver as the site of its Mid-season Meeting this year. Details of the technical sessions which followed are reported later.

At the Reception: (l to r) Mr. H. H. Ollis (Chairman, Vancouver Branch), Mrs. Wells, Mrs. Ollis, G/C H. R. Foottit (President, C.A.I.) and Mr. E. C. Wells (President, I.A.S.)

THE DINNER

Before the Dinner, those attending were entertained at a Reception generously provided by the Aviation Industry of the Vancouver International Airport. The President and Mr. and Mrs. Ollis received the guests.

Those sitting at the Head Table at the Dinner, in addition to the President and Principal Speaker, comprised members of the Council representing the Halifax-Dartmouth, Montreal, Ottawa, Toronto, Winnipeg and Vancouver Branches, the Chairmen of the technical sessions and, observing the "area rule", senior Executives of Sustaining Member Companies in Vancouver.

In his address the President laid stress on the number of "firsts" associated with the Meeting. One of these was the fact that it was the first C.A.I. Meeting attended by three Presidents, namely the Principal Speaker, Mr. E. C. Wells, President of the Institute of the Aeronautical Sciences, Mr. Ryan, Vice-President of Canadian Pacific Air Lines (a Sustaining Member) and President of the Air Industries and Transport Association, and himself. Then again Vancouver was the first new Branch of the Institute to be formed after the C.A.I. came into being by the transformation of the previous organizations in Toronto, Ottawa and Montreal; and it was the first Branch to develop a Student Section, after the transformation of the I.A.S. Student Branch in Toronto. He paid tribute to Mr. I. A. Gray and Mr. T. W. Siers who had done so much to organize the formation of the Branch within six months of the formation of the Institute and to Mr. R. J. McWilliams who had been responsible for encouraging the Cadets at Royal Roads to form themselves into a Student Section.

Mr. Ollis thanked the President for his remarks about the Branch and attributed its success to the enthusiasm of many of its members (*a point which had been amply demonstrated by the manner in which the Meeting had been run – Sec.*). He expressed the hope that it would not be long before another Institute Meeting was held in Vancouver. The President then called on the Principal Speaker.

Mr. Wells' address is reproduced elsewhere in this issue. It was a succinct

Mr. H. H. Ollis, Chairman of the Vancouver Branch, declaring the meeting open.

reappraisal of education, of the need for balance, of the need for better rather than more scientists and engineers, and of the responsibilities of the technical societies, such as the I.A.S. and the C.A.I., in this field. The Past President, Mr. T. E. Stephenson, in moving a vote of thanks, referred to the honour which Mr. Wells had bestowed upon the Institute in addressing this Meeting and to the pleasure with which the C.A.I. welcomed the President of the I.A.S.; he mentioned particularly the cooperation and help which the I.A.S. had always offered.

In closing the Meeting, the President thanked the Companies which had been the hosts at the Reception and the Vancouver Branch Programmes Committee. He expressed the hope that many members of the Branch would attend the Annual General Meeting in Toronto in May, ending his remarks with the lamentable Centennialism "B.C.ing you".

TECHNICAL SESSIONS

The following reports on the technical sessions have been submitted by members of the Vancouver Branch.

Morning Session, February 27th
Reported by A. L. Bingham

TEST FLYING

The 1958 Mid-season Meeting of the CAI was officially opened by Mr. H. H. Ollis, Chairman of the Vancouver Branch, who welcomed the seventy delegates and guests attending the first Session.

The Session, under the chairmanship of Mr. E. L. Bunnell, Chief Test Pilot, Bristol Aircraft (Western) Ltd., got under way with a paper on "Some Problems in Airline Turbine Transport Operation", given by Capt. R. J. Baker of Trans-Canada Air Lines.

The speaker called on his extensive experience with Viscount aircraft to illustrate some of the major problems facing the airlines in particular, and the entire aircraft industry in general. Problem areas, such as ground handling, noise suppression and the need for clearer communication between ground control and aircraft, were pointed out. Capt. Baker very aptly depicted the communications problem with a tape recording of a typical garbled radio transmission as heard from the cockpit of a Viscount approaching Montreal Airport. The need for very accurate flight planning plus quick and accurate traffic control, in order to operate the turbine aircraft as safely and economically as possible, was also brought out. Mr. Baker feels that radar surveillance during the landing, takeoff and en route phases is the best foreseeable solution to the traffic control problem.

The second paper, "Flight Testing in the Space Age", was presented by Mr. A. W. Blackburn of North American Aviation. Mr. Blackburn is a Science graduate of M.I.T. and a test pilot for the F-86, F-100 and F-107 development programs and is, therefore, well able to talk on this nebulous subject.

Mr. Blackburn used, as an example, Wernher von Braun's "Mars Project" to illustrate the testing necessary before a manned space vehicle is actually launched. The proposed methods of testing each of the three rocket stages separately to learn their flight characteristics, plus the testing of the crew to determine the human limitations, were pointed out. The American satellite now circling the globe is sending out information on various factors which will affect the future design of space vehicles. Information already received from the satellite indicates that the level of cosmic radiation will not seriously hamper man's attempt to conquer space. In closing, Mr. Blackburn assured everyone present that the pilot is not liable to be replaced by an electronic "black box", even in the era of space travel. Pound for pound, there isn't a computer made that can match man's judgment and ability.

The last paper in the Session was presented by Mr. R. H. Frost of Stanley Aviation, on the subject "Supersonic Aircraft Escape Systems".

Mr. Frost first itemized the various problems involved in safely escaping from a supersonic aircraft, such as

(1) deceleration loads,
(2) tumbling
(3) oxygen
(4) flailing of arms and legs, and
(5) tail clearance.

He then briefly outlined the history of ejection seats, indicating the methods used to solve the above problems.

Deceleration loads on the pilot during an ejection are combatted by stabilizing the seat in a minimum drag attitude, and giving it a positive L/D ratio to lick the tail clearance problem. Minimum drag, of course, results in minimum 'g'

Test Flying Session: (l to r) Capt. R. J. Baker, A. W. Blackburn, E. L. Bunnell (Chairman) and R. H. Frost

loads during the deceleration. The seat may even be equipped with rocket thrust to combat the deceleration loads.

Stabilizing the seat to prevent tumbling can be done with the use of three-stage parachute systems, or with stabilizing aerofoil surfaces on the seat.

Flailing arms and legs are prevented by using limb clamps which automatically pin the pilot's arms and legs in the correct position after the ejection cycle is started.

There is one other advantage to stabilizing the seat in a minimum drag position. This position puts the pilot in a horizontal attitude, with his face and oxygen equipment protected from the wind blast which would normally tear this equipment loose.

Mr. Frost accompanied his lecture with slides showing the development of the various safety devices, and a movie showing these devices in use during the actual rocket sled tests.

Unfortunately, the Session got off to a late start, leaving no time for the normal question period after each lecture. However, the information presented and the manner of presentation were clear and concise and of interest to all delegates.

Afternoon Session, February 27th

Reported by J. A. Meagher

OPERATIONS AND SAFETY

This Session was chaired by Mr. E. L. Bunnell, Chief Test Pilot, Bristol Aircraft (Western) Ltd., who introduced the first speaker, S/L J. W. Borden, Officer Commanding, 121 Communications and Rescue Flight, RCAF. S/L Borden's paper was titled "Search and Rescue in Canada".

The speaker introduced the assembly to the Canada-wide organization of the RCAF Search and Rescue Group and particularly to 121 Flight at Vancouver.

We were told of the vast communication network operated through the Rescue Coordination Centres, of the co-operation of the RCMP and Marine organizations. In addition to the RCAF personnel at the Coordination Centre, a qualified Ships Captain is on the staff as an adviser on marine problems.

We in B.C. are aware of the difficult flying conditions due to our terrain and appreciate the many problems faced by the RCAF Search and Rescue Group. Our impression was that the important task undertaken by the RCAF was in very capable hands.

The next paper in this session, "Airline Planning for Jets", was presented by Mr. J. A. Stern, Staff Engineer, United Air Lines Inc.

Mr. Stern's address reviewed the airline's approach to a study of the many problems to be overcome and the many questions to be answered before an airline could accept jet transport.

Mr. Stern pointed out the inadequacy of existing airports to handle jet transport aircraft and some thoughts on exploring new ideas to speed up traffic in the approach area as well as on the ground. The economics of not only the aircraft but of supporting services, such as navigation, communication systems and airport facilities, were important and subject to research by the airline.

(We regret that no report was received of the third paper in this Session —Sec.)

Evening Session, February 27th

Reported by J. A. Gillies

VANGUARD

The Chairman for this Session was Mr. H. H. Ollis, Manager, Aviation Electric (Pacific) Ltd., who introduced the speaker, Mr. J. T. Dyment, Chief Engineer, Trans-Canada Air Lines.

Mr. Dyment gave a very interesting and comprehensive talk on the "Selection of the Vickers Vanguard by Trans-Canada Air Lines". He opened the subject by pointing out that most airlines have a long range program which covers up to a ten-year period. When this program indicates a new type of airplane is to be purchased, the selection study must start four to five years before required delivery. The selection study takes approximately two years of this time and the remainder is required for the manufacture of the chosen aircraft.

Mr. Dyment confined his talk to the selection study period. He pointed out that this study starts with top management calling together specialists from operations, planning, sales, accounting and engineering departments, and obtaining an agreement upon common assumptions to use in the more detailed forecast studies. These assumptions may cover the following:

(a) expected economic level of the country and/or areas,
(b) competitive factors,
(c) routes and cities to be served,
(d) general type of equipment being considered,
(e) general picture of rates to be charged,
(f) total passenger traffic, mail and cargo expected,
(g) maximum load factor desired,
(h) an acceptable approach to schedules,
(i) likely interest rates for borrowed money, and
(j) a review of the Company's objective in relation to its performance, profits etc.

The speaker went on to describe how the above items are considered and how

Operations and Safety Session: (l to r) I. G. Barrowman, J. A. Stern, E. L. Bunnell (Chairman) and S/L J. W. Borden

each affects the final aircraft selection. This study indicated that three general types of airplane would best suit the whole airline; a local intercity or short haul feeder airplane, such as their Viscount, a large intercontinental or long haul transcontinental airplane, such as the DC-8, and the intermediate type for major intercity or medium range services, for which the Vanguard was selected.

In making these selections, the engineering department studied manufacturers' data on types of aircraft that would be available in time and meet the specific requirements. The initial investigation on any one type, such as the medium range aircraft, reduces the number of contenders to a few likely prospects. Detailed analyses performed on these few will further reduce the number for final consideration. In the case of the Vanguard, the number of airplanes was reduced to two, the Lockheed Electra and the Vanguard. However, owing to new models and redesign, the detailed analysis had to be redone with the Douglas DC-9 and the Vickers Vanguard coming out on top.

Special Evening Session: (l to r) J. T. Dyment and H. H. Ollis (Chairman)

The operations planning department then took over the study by applying the prospective airplanes and engineering calculations to the actual routes for which they would be best suited and integrating them with the existing TCA fleet. From this study the operating economics for each aircraft are determined, based on desired schedules and the number of aircraft required to meet these schedules. The results of this study are discussed at a meeting with all operations department heads and the final decision is eventually made, in this case in favour of the Vickers Vanguard.

Mr. Dyment outlined the advantages of both the Vanguard and DC-9 and stated that the six strongest points favouring the Vanguard are as follows:

(1) As a result of the study of integrating the DC-9 or the Vanguard with TCA's existing fleet of Viscounts and DC-8's, a surprising result evolved. It was found that considering the amount of traffic that would actually be carried by this intermediate type of airplane, its most influential flight leg length would be in the neighborhood of 350 miles rather than over 500 miles as originally expected. This shorter, predominant leg length was due to the very heavy traffic over the triangle Montreal-Toronto-New York.

The net result was that, with both airplanes carrying the same amount of traffic, a fleet of Vanguards could do it at a cost of around eight million dollars a year cheaper than a fleet of DC-9's. This large saving in operating costs would result in lower fares and improved service being given to the travelling public than could be done with the pure jet DC-9.

(2) The trend of traffic increase accompanied by reduced fares points to the need for a high-density passenger airplane on many relatively short flight legs. There will be a real need for an airplane capable of carrying at least 90 passengers on many flight legs initially planned for the Viscount. As these legs will generally be below 400 miles, a large-fuselage propeller-turbine airplane will be much better able to provide these services when needed at a low cost.

(3) The width of the fuselage of the Vanguard is such that six-abreast seating could be installed for future short, high-density flight legs and thus increase still more the economic advantage of the Vanguard.

(4) The large capacity of the belly cargo compartments in the Vanguard make this airplane much more flexible in its ability to handle heavy cargo and mail loads at off-hours from a passenger's standpoint, and thus should enhance the utilization of the airplane on the intercity services where passengers in general avoid flying between 11.00 pm and 7.00 am.

(5) There will be less likelihood of TCA creating a noise problem at the small airports with the Vanguard than with the DC-9.

(6) Another key to the unanimous decision for recommending the selection of the Vanguard was the belief that TCA will best be served by buying Vanguards for its medium range services, which airplanes will gradually take over services now planned for the Viscount as soon as traffic density permits, even to the extent of pushing a certain number of Viscounts out the bottom for sale. On the other hand, it is believed that the DC-8 will prove most capable of taking over services initially planned for the Vanguard as soon as traffic density or the need for the increased speed dictates.

Mr. Dyment outlined a few of the chief characteristics of both the Vanguard aircraft and the Tyne turboprop engines and emphasized that this aircraft is not a blown-up version of the Viscount but is a new design. He also pointed out that the engine was controlled by a simple single lever with no "black box", which he attributed to good design based on extensive knowledge of turbine engines gained by the manufacturer.

The speaker concluded his talk by stating that due to the magnitude of training involved in introducing the DC-8 into TCA's fleet early in 1960, TCA will not be able to take delivery of the Vanguards until near the end of 1960. He also stated that by the summer of 1961, TCA expects to operate a combined fleet of twenty Vanguards, six DC-8's and fifty-one Viscounts. This, he believes, will make TCA the first

airline in the world operating an all-turbine fleet.

Mr. Dyment's talk was followed by an interesting question and answer period.

In reply to a question on the operating cost of the bigger fuselage of the Vanguard, Mr. Dyment stated that added cost would be due to added skin friction only which would reduce speed by 3 to 4 mph. This cost was well worth the flexibility and saves TCA from buying approximately six cargo aircraft for the carriage of mail and air express.

During his talk, Mr. Dyment referred several times to the carriage of cargo and emphasized the large cargo space in the Vanguard. When questioned on the economics of using an aircraft like the Vanguard for cargo purposes, Mr. Dyment stated that the term cargo was used rather freely as he meant to imply the mail and air express.

In discussing the studies involved in choosing an aircraft, Mr. Dyment stated that they used 50% winds for economic purposes and 90% winds for schedule purposes. Being questioned as to the reason for these two wind factors, since most pilots will ask for a fuel load based on 90% winds regardless of weather, he replied that a new outlook on fuel reserves must be made. Fuel reserves must be established from a mathematical standpoint and the quantity based on the flight plan. Before this method can be incorporated effectively, the traffic control system must be improved.

When asked about passenger appeal, Mr. Dyment replied that TCA were aware of this factor. The Vanguard will have more appeal than the Viscount due to its size. The jet will have more appeal than the Vanguard due to speed, size and smoothness. The Caravelle is the best yet in this regard. However, all aircraft will improve with development.

The question was asked regarding the losses that are anticipated due to silencing and the cost of overhaul of silencing equipment. Mr. Dyment replied that they could not afford more than 2% loss in thrust for noise suppressors. At the time of signing the DC-8 contract, the losses were higher than 2% but subsequent developments have brought these losses into line. TCA do not anticipate high overhaul or maintenance costs. However, they were 240 lb low in estimating the weight, but this and other factors are adequately covered in a 1,000 lb weight factor added during appraisal.

In reply to a question as to whether or not the Electra was too late, Mr. Dyment stated that this aircraft was early enough but the cargo holds were too small and that TCA did not like the Allison engine. However, he now thinks that the Allison engine will be good but it is of an old design. The Tyne engine could have been installed but this would have increased the cost of the aircraft. He stated that the cost of operation of the Electra will be high; the Comet will be 45% higher with 25% less seats. The Britannia and the Canadair CL-44 were also considered but their ranges were too long, resulting in excessive structure being carried around on medium range flights.

Mr. Dyment was thanked by Mr. I. A. Gray, Director of Maintenance and Engineering, Canadian Pacific Air Lines, Ltd.

Morning Session, February 28th

Reported by F. N. A. Ramsay

ELECTRICS AND ELECTRONICS

This Session was opened by S/L A. E. Kelly, Senior Telecommunications Officer, RCAF Stn. Cold Lake, who was in the chair. The first speaker introduced by S/L Kelly was Mr. Z. Poznanski of the Canadian Marconi Co., who was substituting for Mr. K. C. M. Glegg, who was unfortunately unable to be present. Mr. Poznanski, apologizing for the fact that he had had little time for reviewing Mr. Glegg's paper on the subject, "The Doppler Sensor in Air Navigation", proceeded to discuss the subject very effectively, aided by appropriate slides.

The speaker outlined the shortcomings of the normal processes of dead reckoning air navigation by discussing D.R. principles and limitations. The classic triangle of velocities was utilized for this purpose. Basically any D.R. system requires knowledge of the following quantities: wind speed, wind direction, true air speed and heading; with these elements ground speed and track can be computed and an aircraft's position obtained. Two of the foregoing ingredients, namely, wind speed and direction, require constant monitoring in order to have accurate dead reckoning and that of true air speed to a somewhat lesser extent. Mr. Poznanski proceeded to outline what a Doppler Sensor will do with respect to obtaining the necessary information for accurate dead reckoning navigation. Briefly, the Sensor is a device which permits accurate measurement of ground speed and drift angle. These components may be substituted for the components of wind direction, wind speed and true air speed leaving only the heading information for one to complete the dead reckoning process.

The electronic principle of the Doppler Sensor was outlined. Specifically, the system working at 3 cm (X-band) utilizes a transmitter-receiver and suitable antenna. The transmitter radiates a frequency towards the earth in a small narrow beam. The earth reflects back a portion of this energy which frequency-wise is changed due to Doppler effect to a new frequency. The difference in frequency due to Doppler effect is a measure of the aircraft's ground speed. To obtain drift measurements, two beams are radiated, one to the left and the other to the right of the aircraft, both depressed so as to strike the earth as for ground speed measurements. These beams are zeroed or "nulled" on the ground with reference to the fore and aft axis of an aircraft (i.e. each beam having equal displacement). If in flight the aircraft is carrying drift, one beam will have a higher component of ground speed than the other. The antenna is, therefore, rotated until a new "null" position is obtained. The angle so described to obtain this "null" is the aircraft's drift angle. This process is automatic so that a continuous indication of drift angle is always present. A further refinement of the foregoing is the "Janus" antenna system, whereby four beams are simultaneously utilized to obtain ground speed and drift angle.

The speaker described some typical types of presentations from a simple ground speed and drift type (miles left or right of track) to the more complex types giving such information to the pilot as position in latitude and longitude, ground speed, track, wind direction and velocity.

Mr. Poznanski spoke at some length on errors associated with a Doppler Sensor. These errors were divided into three groups, namely, aircraft source error, external source errors and actual sensor sources of error. These errors were discussed in great detail by the speaker. Despite the large number of possibilities, the speaker pointed out that actually the Doppler Sensor system is very accurate as the overall system error does not exceed more than approximately 0.4%.

Much interest was aroused by the speaker's subject judging by the number of questions raised at the completion of the talk. Space does not suffice to list the great number of questions thrown out by the audience. Two questions which perhaps were of general interest were on the subject of the weight of the equipment and the effect of weather and terrain. According to Mr. Poznanski, the equipment weight at present is approximately 60 lb. As to the weather and terrain affecting the

Electrics and Electronics Session: (l to r) L. J. Dennett, C. J. Campbell, S/L A. E. Kelly (Chairman) and Z. Poznanski

operation of the Doppler Sensor, these elements have little, if any, adverse effect on system operation.

The second speaker of the Session was Mr. L. J. Dennett of the Decca Navigator Co., Toronto. Mr. Dennett's talk embraced the Decca Navigator and long-range Dectra systems. A very illuminating description was given of the basic Decca system and what it can do. A Decca system comprises a group of stations or chains. Each has a "master" station with three supporting "slave" stations operating in the low frequency band of 70-130 kcs. The principles of "phase comparison" (i.e. time difference) is utilized by measuring the signals of "master" and "slave" stations. For a given position, in space, there is a definite relationship time-wise between signals received from the "slaves" as related to the "master" station. These time differences are reproduced on special charts as hyperbolic lines of time difference. The intersection of two or more hyperbolic lines from a group of stations provide a "fix" of an aircraft. This information is presented to the flight crews either on instruments called Decometers or via flight log — the latter giving continuous position information by means of pen and ink recording on a driven roll chart. Using the Decometers (which are coded red, purple and green), one must note the readings and apply these to the special hyperbolic charts to obtain aircraft position. Every minute the Decca transmitters transmit a special transmission which actuates a fourth instrument called a Lane Identification Meter. The information on the meter provides a check on the individual Decometers which can be corrected if in error.

Mr. Dennett outlined some of the advantages that the Decca Navigator System has to offer. These are enumerated as follows:

(1) Ease of interpretation by the flight crew.

(2) Economy due to best track being flown.

(3) More air space available due to unlimited courses available between points A and B. This is also an advantage from ATC's standpoint.

(4) Flexibility under adverse weather conditions.

The speaker gave a brief description of the new long range Dectra system presently undergoing evaluation tests on the North Atlantic routes. This system basically works on the same phase comparative principles as the Decca system. Here, however, only two main station groups are utilized, one being in Newfoundland and the other in England.

Some interesting slides were shown which helped the audience visualize the various components comprising the two systems described by Mr. Dennett.

Mr. Dennett said that interest in this form of navigation is increasing. Present plans call for installation of a system in the New York area for helicopter usage. He also said that a demonstration of a Decca Navigator system was going to be set up on the west coast for some time in April.

In conclusion, the speaker voiced the opinion that he felt that Decca and its long-range counterpart, Dectra, working in conjunction with the new Doppler Sensor systems, would afford a simple pilot-operated navigation system for the jet age which we are about to enter.

One pertinent question among the many asked, after the speaker finished his talk, was whether a temporary phase shift or other breakdown of the ground station equipment introduced large navigational errors. To this Mr. Dennett replied that any temporary interruption would be immediately noticed by the pen moving violently in the case of the flight log presentation, or a particular Decometer increasing its reading rapidly. The Lane Identification Meter would also warn the user of any malfunctioning as it is actuated every minute for information transmitted by the ground stations for checking purposes.

Following the speaker's talk, an extremely interesting film was exhibited showing a typical Decca installation in a BEA helicopter. This system utilized the flight log for aircraft position presentation to the pilot. The film portrayed a helicopter flight taken in the south of England. Visual ground references were shown and at the same time the viewer was given a glance at the flight log which showed the recording pen tracing out the aircraft's track on the chart of the area being flown.

Mr. D. G. Campbell, Director of Telecommunications, Trans-Canada Air Lines, was the last speaker of the morning Session. Mr. Campbell opened his talk by stating that the electronic systems are said to be the "nervous" system of airborne operations. This role, however, has been one of constantly increasing importance and is now no longer confined only to airborne operations, as electronics embrace a large number of airline functions, such as reservation systems, accounting systems, logistics, scheduling and planning the operation of airlines.

The speaker then proceeded to enumerate and discuss the many electronic arms which a modern airline, such as Trans-Canada, utilizes today. Starting with the airborne aspect, Mr. Campbell described typical air to ground communication equipment that is normally used aboard the airliners today. This equipment comprises both HF and VHF transmitters and receivers, from 144 channels in the case of HF and up to 360 channels for VHF.

Intercommunication equipment, which is now transistorized, is utilized for communication between all flight crew members. For navigation purposes, automatic direction finders are installed and VHF omnirange equipment, marker receivers and appropriate ILS receivers for instrument landings. On overseas flights, additional electronic equipment is carried in the form of a Loran receiver and indicator and a radio altimeter. Ancillary equipment, such as dual gyro magnetic compass, together with a standby magnetic compass, is carried. No navigation system, however, would be complete without an indicated air speed meter, pressure altimeter and temperature indicator in order to correct for true air speed. One additional navigational instrument which is carried on overseas flights is the periscopic sextant. A new additional navigational aid is being rapidly fitted on most modern aircraft, according to Mr. Campbell, and that is the weather radar equipment which enables the pilots to avoid areas of turbulence, precipitation and thunderstorm activity. The next electronic arm discussed by Mr. Campbell was that of point to point communications. The speaker outlined how TCA have now switched from the old manual type of teletype, using the "torn tape" relay method, to that of the Western Union plan 54 semi-automatic teletype switching system. This system in effect eliminates all manual relay on TCA's domestic and USA stations for point to point traffic. Slides showing a typical semi-automatic set-up were shown to help the audience visualize this system. It was stated by the speaker that with this new system TCA can now expect to give five minute service from any point on their system to any other point that they service. An idea of the volume of traffic handled by TCA's domestic system was given when Mr. Campbell stated that some 40,000 messages per day are transmitted. Apart from the teletype system, TCA now have two separate private long line telephone circuits from coast to coast. One of these is for airline reservations and the other for operations. Improved communications between Canada and the U.K. have recently been developed by means of a leased teletype circuit in the new trans-Atlantic telephone cable. TCA still maintains ground radio stations at each of their domestic stations. These are principally VHF stations for air to ground service but the system is augmented by the use of high powered HF installations at TCA's main flight despatch centres.

The speaker gave the audience a peek into the future by way of new developments that are taking place electronics-wise. In the communications field the trend is towards VHF air-ground communications for domestic use and high frequency communications for international service. Great effort is being made to increase reliability of equipments and towards reducing the weight and size of same. Much progress has been made in this latter direction. Comparison was made between the weight of the present HF communication equipment in the Super Constellation, which weighs 457 lb, and that to be installed in the new DC-8's, which will weigh only 196½ lb. Single side band communication is being followed with interest by TCA and also that of automatic data processing, although the speaker said that he did not expect implementation of these principles for some time yet. On international routes, considerable success has resulted from the airborne radio teletype tests done by TCA in conjunction with other airlines. On the navigation side, Mr. Campbell outlined some nine different navigation systems that are either a reality or will be in the future. He pointed out that at present, despite the advances made, no reduction has been made in the number of "black boxes" that are carried on an airliner, but rather there has been an increase in the number carried. At present TCA, in conjunction with Canadian Marconi and Computing Devices, are evaluating a Doppler Sensor together with an electronic computer which will provide ground speed and drift angle information to the flight crew. This system will be under evaluation for the next few months. It is Mr. Campbell's hope that if this system is successful the airline may be able to eliminate some of the duplicate systems now carried, thus saving valuable payload.

Automatic reservations systems were covered by the speaker. TCA, in conjunction with Ferranti Electric, have developed a system which appears to be a very satisfactory solution to the airlines reservation problems. This system is built around "agent sets" which are named Transactors. The Transactor is a mark sense device, which can read pencil marks made on a card which is inserted in the Transactor. Mr. Campbell stressed the fact that this device is a static card reader and that no electronic or mechanical scanning of the card takes place. The card is clamped into the Transactor where it actuates micro-switches at the base of the slot and the marks are detected by some 300 precious metal reading heads built into the face of the slot. These marks

A combined T.C.A./C.P.A.L. Exhibit: on the left, Mr. H. H. Ollis and G/C H. R. Foottit and on the right a group of Student members, visiting from the Canadian Services College, Royal Roads

so detected are converted by a coupler to a high-speed binary code which is transmitted over land lines to a central electronic computer at a reservation centre. The computer at the reservation centre makes a search, as instructed by the marks, and transmits its reply, which results in the card which was originally inserted being punched. This whole operation is designed to handle transactions during peak periods in a maximum of three seconds. The speaker wished to impress upon the audience that although this system is applied for reservations, it is an equally flexible system for general business usage. Slides were shown covering the various pieces of the automatic reservations systems and a detailed sketch was drawn on the blackboard by Mr. Campbell outlining how the basic system operated. Of interest to those of us in the west is the fact that we may see the first part of the system implemented in the Vancouver-Victoria and Seattle region. This, in your reporter's opinion, is quite apropos considering that TCA's first flight occurred between Vancouver and Seattle in the year 1937. As with the previous speakers, many questions were raised. One was perhaps of general interest and that was the effect of what controlled priority in usage of the automatic reservation system. Mr. Campbell stated that with the maximum delay of three seconds under peak loading, personnel would not be aware of any delay or waiting period.

Inspection and Maintenance Session: (l to r) R. J. McWilliams, H. W. Grant, J. A. Clarke (Chairman) and J. R. Beale

Afternoon Session, February 28th

Reported by L. C. Bryan

INSPECTION AND MAINTENANCE

Mr. J. A. Clarke, Manager, Quality Control, Northwest Industries Ltd., chaired this Session and opened the proceedings by introducing Mr. J. R. Beale of the Aluminum Company of Canada Ltd., who presented a most enlightening paper entitled "Aluminum Corrosion — An Unnecessary Evil".

His talk began with the application of aluminum protective coating (Alclad) and methods of applying. Different forms of stress corrosion were discussed. This type of corrosion was found to be the result of stresses formed during the manufacturing process and pointed out the importance of rigid control of these processes, particularly the control of temperatures during heat treatment. The speaker remarked on the astounding number of foundries which still guess at temperature rather than make accurate measurement by the use of precision instruments. It was noted that contamination (i.e. sulphur formed in smelting furnaces) can accelerate corrosion in the final product.

Another source of corrosion which should be considered is the result of abrasive action between two pieces of material and can occur even during shipment. For instance, fretting corrosion can occur as the result of movement of one sheet of aluminum against the other during shipment. This brings out the importance of proper packaging and storing methods.

Most of the other forms of corrosion brought to our attention were electrolytic in nature. Examples given were crevice corrosion, which is the result of oxygen variation; galvanic corrosion, which is the result of dissimilar metals in contact; and electrochemical corrosion, resulting from the presence of moisture in combination with contaminations produced by exhaust gases, welding flux and certain types of wood etc. Even the handling of aluminum without the precaution of using clean gloves, particularly in warm weather, was mentioned as a cause.

Mr. Beale pointed out that a "clean" airplane not only is pleasing to the eye but is protection against corrosion created by a combination of condensation, which occurs due to ambient temperature and humidity changes, and contamination from airborne dirt and grime. For complete protection, this cleanliness should extend to all those "hard to get at" sections.

The speaker concluded his talk by summarizing the various methods of protection, including anodizing, conversion coating, painting and varnishing.

It is believed Mr. Beale's paper added much to our knowledge of corrosion problems and their prevention.

The next paper in this Session was a most interesting one entitled "Non-Destructive Testing of Aircraft Materials", presented by Mr. H. W. Grant of Standard Aero Engines. Due to the time limitation, Mr. Grant confined his talk to two techniques, namely magnetic particle inspection and fluorescent penetrant inspection, more commonly known as magnaflux and zyglo.

The extreme reliability of the magnaflux method was pointed out and, as in every system, the limitations and the need for trained personnel for its application. False indications can be given, particularly when the longitudinal fields are used to detect flaws lying transverse to the long axis of the part and hence the requirement for trained personnel in order to interpret correctly the results of the tests. Mr. Grant pointed out the advantages and disadvantages from cost and operational points of view.

Observations were made on the alternating current magnaflux equipment and the direct current equipment, and between the "continuous" method, which requires a continuous power application, and the "residual" method, which depends on the retentivity of the material under test to maintain the field.

We also learned the advantages and disadvantages of the wet method, which involves the application of the magnetic powder to the surface of the item under inspection by means of a liquid vehicle in which the powder is suspended, and that of the dry procedure which involves direct application of the dry powder. The speaker warned of the hazards involved should the material tested be left in a magnetized state and free to pick up metallic contamination, which could cause serious damage. Demagnetizing is accomplished by alternating current operated solenoid demagnetizers.

Mr. Grant then clearly explained the zyglo method of flaw detection. He pointed out that this method is confined to the detection of defects which are open to a surface, as this method involves applying a penetrant which remains in a defect and holds the "chalk-like" developer, which in turn is detected by near-ultra-violet light. In the speaker's words, the defect will then stand out "like a bright moon in a dark sky". The zyglo method also requires trained personnel to properly interpret the results of the tests.

The talk was amply supported by film slides showing well-defined examples of fault detection and Mr. Grant should be commended on his well-composed and delivered paper.

(We regret that no report was received of the third paper in this Session —Sec.)

Copies of Papers

Preprints of most of the papers presented at the Mid-season Meeting on the 27th and 28th February are obtainable from the Secretary.

ANNUAL GENERAL MEETING

KING EDWARD HOTEL
TORONTO

26th and 27th May, 1958

May 26th	Morning—9.00 a.m. to 10.30 a.m. .	Business Meeting	
	Morning—10.45 a.m. to 12.00 noon .	Test Pilots Section	Concurrently
	Morning—10.45 a.m. to 12.00 noon .	Propulsion Section	Concurrently
	Morning—10.45 a.m. to 12.30 p.m. .	Engineering Administration	Concurrently
	Afternoon—2.30 p.m. to 5.00 p.m. .	Honours and Awards and W. Rupert Turnbull Lecture	
	Evening—7.00 p.m.	Dinner	
May 27th	Morning—9.00 a.m. to 12.00 noon .	Production Engineering	Concurrently
	Morning—9.00 a.m. to 12.00 noon .	Design and Application of Computers	Concurrently
	Afternoon—2.00 p.m. to 5.00 p.m. .	Ground Equipment	Concurrently
	Afternoon—2.00 p.m. to 5.00 p.m. .	VTOL/STOL	Concurrently

The Principal Speaker at the Dinner will be

A. H. ZIMMERMAN
Chairman, Defence Research Board

BRANCHES

CALGARY BRANCH

The Council has approved the formation of a Branch of the Institute at Calgary. Since the formation of the C.A.I. there has been a small group of members in Calgary, including several Student members attending the Provincial Institute of Technology and Art, but their numbers were insufficient to permit the formation of a Branch under the terms of the Bylaws. During the last year, since he took over as "Interim Secretary", Mr. J. D. Zmurchyk has been working hard to interest more people in applying for membership and there has recently been a significant increase, carrying the figures well above the 20 required.

Mr. Zmurchyk, and Mr. W. E. Jamison before him, are to be congratulated on the success of their endeavours. It should now be possible to hold elections, build up the membership and generally organize their committees, to be ready to start a full and useful season of meetings in the fall.

NEWS

Cold Lake

Reported by F/L L. S. Lumsdaine

January Meeting

The meeting took place in the library of the Sergeants' Mess at 20.00 hours on Thursday, 30th January. The Chairman, W/C R. D. H. Ellis, introduced the speaker, Dr. J. F. Perrier of Canadair Ltd., who gave an interesting talk on guided missiles. The Branch is grateful to Dr. Perrier for having taken the time and trouble to visit us.

February Meeting

At 20.00 hours on Tuesday, 18th February, a meeting was held in the library of the Sergeants' Mess. Mr. Poole, Chief Engineer of Saskatchewan Government Airways, Prince Albert, was the guest speaker. After an introduction by the Chairman, Mr. Poole gave an interesting talk on the technical and operational aspects of "bush flying" operations since the early thirties. Well qualified in this subject, Mr. Poole was able to illustrate his talk with accounts of many first-hand experiences of the early days of aviation in Canada and to point out the technical advances made through the years. The economics and peculiar problems of small non-scheduled operators and the methods of solving the problems of salvage, repair and major overhaul were discussed.

Edmonton

Reported by C. W. Arnold

January Meeting

The meeting was held at 700 Wing RCAF Association Mess on Friday, 31st January. Forty members and guests were present. Mr. J. W. Bristow, Chairman, presided.

Minutes of the previous meeting were read and Branch business was discussed.

The Chairman then rose to introduce Mr. H. C. Luttman, Secretary of the CAI, who addressed the gathering. Mr. Luttman said that he was happy with the progress made by the Branch during the past year. He said that from the time the CAI was formed, it had been supported in part by the Royal Aeronautical Society and the Institute of the Aeronautical Sciences. It was now felt that with the continuous growth of the Branches across Canada, the CAI had "come of age" and could take its place alongside these great institutions without having to rely on them for financial assistance. This was the reason for the recent increase in membership dues in some of the grades.

Edmonton will have the honour of playing host at the 1960 Mid-season Meeting and a full programme of events will be worked out. Mr. Luttman closed by urging that as many members as possible attend the Mid-season Meeting to be held in Vancouver at the end of February.

Mr. C. C. Young then introduced the guest speaker, Dr. E. P. Cockshutt of the National Research Council in Ottawa. The subject of Dr. Cockshutt's talk was "Engines for Vertical Takeoff". This was most interesting and was illustrated by slides showing diagrams of the various approaches to the problems of vertical takeoff. Dr. Cockshutt described some of the research being carried out at the present moment and invited members and guests to give their opinions. A discussion period followed at the end of which the speaker was thanked by Mr. J. G. Portlock.

Toronto

Reported by J. McKillop

February Meeting

The sixth meeting of the current year was held in the De Havilland Cafeteria on February 26th, with Mr. J. W. Ames in the chair. There was an excellent attendance of 80 members and 87 guests to hear an address by Professor H. Ashley of M.I.T., introduced by Dr. G. N. Patterson. As Prof. Ashley is well-known in the field of aeroelasticity, it is not surprising that he chose as his subject "An Aeroelastician Looks to the Future".

The speaker began his remarks by presenting a brief discussion of the scope of the subject, which is unfortunately not too well understood by a great many in the aeronautical engineering field. The "classical" problems of divergence, control reversal and flutter were outlined and some more recent problems, such as response to gusts, buffet and blasts, and the very important one of alteration of stability characteristics because of aircraft distortion, were briefly discussed. In order to keep the talk within bounds, however, Prof. Ashley chose his own specialty of flutter as his primary subject and, in particular, the research activities carried out at the Institute in this field.

The Aeroelastic and Structures Laboratory at the Institute carries out a considerable programme of wind tunnel flutter work. The theory of flutter model design was first presented for low speed models in which Mach No. effects are not simulated. Types of model construction designed to simulate different wing structures were illustrated with slides. Several novel wing types were shown, including circular and very sharp delta planforms. Next, the difficulties involved in simulating proper Mach No. as well as all other flutter parameters were reviewed. The beam type models and the supersonic blowdown test facility in use at M.I.T. were described and comparison of some tests with results of current theoretical work was presented. At this point Prof. Ashley interrupted his address to show a film illustrating the M.I.T. technique of supersonic model testing. This film showed very graphically how flutter occurs in many forms and gave a frightening demonstration of the speed with which flutter can destroy a structure.

Following the film, Prof. Ashley resumed his talk dealing with the problems yet untouched by aeroelasticians. First he dealt with missile problems showing that potential flutter conditions exist in a ballistic missile both in the launch and re-entry phases and with an anti-missile in the mid-flight range. The problems of thermal effects, panel flutter and automatic control instability were discussed. In conclusion, Prof. Ashley took his audience out of this world to review some potential dynamic

problems of space vehicles. A short question and discussion period followed the talk and a very successful meeting was wound up with some concluding remarks from Mr. Ames.

Winnipeg

Reported by W. M. Carlson

February Meeting

Thirty-five members of the Branch assembled at the plant of Bristol Aircraft (Western) Ltd. on the evening of February 25th.

The monthly meeting on this occasion took the form of a tour of the Bristol facilities. The members were welcomed by Mr. C. M. Hovey of Bristol and were taken on a tour of the plant in parties of eight, each party guided by a member employee of the Company.

The group assembled in the plant cafeteria for coffee afterwards and a few words by Mr. Hovey. Mr. Hovey referred to the March meeting during which the election of Branch officers for 1958-59 will take place.

Vancouver

Reported by R. W. Van Horne

March Meeting

The meeting was held in the Officers' Mess, RCAF, Sea Island, on the 18th March at 8 o'clock. Thirty-five members and eleven guests attended.

Mr. H. H. Ollis, Chairman, introduced the speaker, Mr. H. G. Packer of Canadian Pacific Air Lines, who spoke on "Statistical Approach to Quality Control in Airlines Maintenance".

In his talk, Mr. Packer proceeded to show the need for detailed history of past performance of the various types of components and units and probability factors to be considered in scheduling the removal to overhaul of the various units. He further pointed out that each operator must consider his own case since stage lengths, operating conditions and standards of overhaul have a large bearing on the probability of premature malfunctioning necessitating removal, and it is not possible to use the same scheduling as another airline. With this information at hand, graphs can be prepared for each type of unit and a month's analysis of units removed can be plotted against time flown and the situation evaluated against a predetermined allowable factor. If premature removals go above the factor, investigation can be started and corrective steps taken.

It is interesting to note that the graphs and charts can be handled by clerical help and the proper people informed of a problem as shown by the charts.

Mr. A. M. Parry of Shell Oil was our second speaker of the evening and showed two very excellent films. The first, "Song of the Clouds", was an outstanding film on the shrinking of our world through air transportation. One wonders how much further it will shrink as airplane development continues. The second film was on the subject of subsonic flight and the shock wave problem at aircraft critical Mach speeds. Shock wave development was very graphically shown by means of colour spectro photography.

Our speakers were thanked by Mr. R. J. McWilliams for contributing to a very interesting and enjoyable evening.

SECTIONS

PROPULSION SECTION

At the meeting of the Council held in Vancouver on the 26th February, 1958, approval was given to the formation of a Propulsion Section. The draft Section Regulations prepared by the Interim Committee were also approved.

Before the case for a Propulsion Section was submitted to the Council, 32 members of the Institute had indicated their interest in such a Section and these will now constitute the first membership. Further applications for membership of the Section should be submitted to the Secretary on the appropriate form. The necessary qualification for membership (the "identifying qualification") is set out in the Section Regulations as follows:

> All members of the Institute who are or have been engaged in technical work on propulsion systems shall be eligible for membership of the Section.

The Propulsion Section will conduct a brief business meeting during the Annual General Meeting of the Institute, to be held in Toronto on the 26th-27th May, 1958.

ASTRONAUTICS

During the last few months, several enquiries have been received about the formation of an Astronautics Section of the Institute. Because these enquiries were being received from several quarters, with no pronounced centre (such as the Propulsion Section had in Toronto), the President appointed a Committee representing some of the principal interests and comprising

Dr. G. N. Patterson (U.T.I.A.)
Mr. R. J. Templin (N.R.C.)
Dr. M. G. Whillans (D.R.B.)

This Committee has been charged with studying the feasibility of establishing such a Section, drafting qualifications for membership and the like. The results of its work will be published shortly; in the meantime the Secretary would welcome further enquiries to enable the Council to assess the extent of the interest and the number of members who might join the proposed Section.

AMERICAN ROCKET SOCIETY

The American Rocket Society has shown great interest in the formation of the Institute's Propulsion Section mentioned above and has given every encouragement. An agreement has been reached between the A.R.S. and the C.A.I. whereby publications of the one society are made available to members of the other at member rates. Under the terms of the agreement *Astronautics*, the A.R.S. monthly magazine, is available to C.A.I. members at $4.50 a year and *Jet Propulsion*, a journal of research and development, is available at $6.25 a year.

These publications may be obtained from the

American Rocket Society,
500 Fifth Avenue,
New York 36, N.Y.

When ordering, C.A.I. members must quote the numbers of their C.A.I. membership cards for the current year.

MEMBERS

ADMISSIONS

At a meeting of the Admissions Committee, held on the 14th March, 1958, the following were admitted to the grades shown.

Associate Fellow

Capt. C. G. H. Daniel, RCN, (on transfer from Member)

Dr. W. R. Franks, Scientific Adviser in Aviation Medicine, RCAF, Institute of Aviation Medicine, 1107 Avenue Rd., Toronto, Ont.

Member

R. C. Arnett, Chief Mechanic, Trans-Canada Air Lines, Vancouver Airport, B.C.: *8462 Wiltshire St., Vancouver 14, B.C.*

W/C D. T. Bain, RCAF, Sr. Equipment General Officer-Coordinator, AMC HQ, Rockcliffe, Ont.: *2068 Honeywell Ave., Ottawa 3, Ont.*

C. A. M. Blizzard, Experimental Material Control Analyst, Dept. 2610, Canadian Pratt & Whitney Aircraft Co., Ltd., P.O. Box 10, Longueil, Montreal, P.Q.

Sgt. R. M. Desjardins, RCAF, Draftsman, Supervisor, AMC HQ, Rockcliffe, Ont.: *Box 443, R.R. No. 1, Ottawa, Ont.*

F/L E. E. Erhart, RCAF, Detachment Commander, 1103 TSD, RCAF Stn. Lincoln Park, Alta.

F/L R. G. Fletcher, RCAF, Chief Engineering Officer, Oxygen Specialist, Institute of Aviation Medicine, Toronto, Ont.: *House 2A, William Baker Park, Downsview, Ont.*

V. J. Hatton, Superintendent of Inspection, Experimental Flight Test, Avro Aircraft Ltd., Box 4004, Terminal A, Toronto, Ont.

G. G. Jacquemin, Aerodynamicist, Avro Aircraft Ltd., Malton, Ont.: *Box 504, Streetsville, Ont.*

J. A. Legris (on transfer from Associate)

H. McKenzie, Chief Inspector, Canadian Pacific Airlines (Repairs) Ltd., Lincoln Park, Alta.: *75 Gladeview Cresc., Calgary, Alta.*

T. A. R. Mottershed (on transfer from Technical Member)

CPO J. V. C. Pitt, RCN, Production Shops Branch Manager, Air Engr. Dept., RCNAS Shearwater, N.S.: *Box 100, Shearwater P.O., Halifax County, N.S.*

LCDR J. A. Ratcliffe, RCN, Sr. Engineer, RCNAS Shearwater, N.S.: *10 Clearview Cresc., Dartmouth, N.S.*

A. G. Reddy, Service Manager, Lucas-Rotax Ltd., Vancouver Airport, B.C.: *2291 Patrick St., South Burnaby, B.C.*

J. J. Thomas, Field Service Representative, Bristol Aero Engines Ltd., Montreal, P.Q.: *418 Truro St., St. James, Winnipeg 12, Man.*

Technical Member

C. A. Brooker, Lead Hand Aircraft Mechanic, Bristol Aircraft (Western) Ltd., Winnipeg, Man.: *1400 Bannatyne Ave., Winnipeg 3, Man.*

A. Day, Jr. Engineer, Design of Test Rigs, Avro Aircraft Ltd., Malton, Ont.: *28 Oakmount Rd., Toronto, Ont.*

B. W. Dollin, Coördination of Maint. and Overhaul with Operational Requirements, Spartan Air Services Ltd., Ottawa, Ont.: *2459 Falcon Ave., Ottawa 1, Ont.*

J. B. French, Research Assistant, Institute of Aerophysics, University of Toronto, Toronto, Ont.

J. F. Godwin, Design Engineer, Fairey Aviation Co. of Canada Ltd., Dartmouth, N.S.: *50 King St., Dartmouth, N.S.*

M. Ivanocko (on transfer from Student)

W. B. Karakuc, Engineer Mechanical Systems, Trans-Canada Air Lines, Montreal, P.Q.: *1439 Valiquette St., Verdun, P.Q.*

R. B. McDonald, Engineer, Canadian Pacific Airlines (Repairs) Ltd., Lincoln Park, Alta.: *P.O. Box 632, Montgomery, Alta.*

G. W. Seale (on transfer from Student)

F/O B. D. Smallman-Tew, RCAF, (on transfer from Student)

Technician

J. Kostyshyn, Engineering Apprentice, Northwest Industries Ltd., Edmonton, Alta.: *6210 - 106 St., Edmonton, Alta.*

Student

R. H. Arnold, Provincial Institute of Technology and Art, Calgary, Alta.: *902 - 23 Ave. N.W., Calgary, Alta.*

C. V. Healey, Aeronautical Engineering II, Provincial Institute of Technology and Art, Calgary, Alta.

L. E. Hillier, Aeronautical Engineering II, Provincial Institute of Technology and Art, Calgary, Alta.

W. B. Large, Provincial Institute of Technology and Art, Calgary, Alta.: *2010 - 37 Ave. S.W., Calgary, Alta.*

R. A. Nelson, Provincial Institute of Technology and Art, Calgary, Alta.: *2223 - 7 Ave. N.W., Calgary, Alta.*

K. D. Olson, Provincial Institute of Technology and Art, Calgary, Alta.: *1639 - 19 Ave. N.W., Calgary, Alta.*

A. P. Pallister, Provincial Institute of Technology and Art, Calgary, Alta.: *1636 - 19 Ave. N.W., Calgary, Alta.*

E. G. Ronald, Provincial Institute of Technology and Art, Calgary, Alta.: *2028 - 36 St. S.W., Calgary, Alta.*

W. N. Sinclair, Provincial Institute of Technology and Art, Calgary, Alta.: *811 - 14 St. N.W., Calgary, Alta.*

C. J. Slemko, Aeronautical Engineering, Provincial Institute of Technology and Art, Calgary, Alta.

C. S. Slemp, Provincial Institute of Technology and Art, Calgary, Alta.: *406 Hendon Dr., Calgary, Alta.*

R. G. Taylor, Aeronautical Engineering, Provincial Institute of Technology and Art, Calgary, Alta.

C. A. Thorne, Provincial Institute of Technology and Art, Calgary, Alta.: *1312 - 17 Ave., Calgary, Alta.*

R. D. Vaage, Aeronautical Engineering, Provincial Institute of Technology and Art, Calgary, Alta.

Associate

R. J. Bourchier, Consumers Research Laboratories Ltd., Toronto, Ont.: *784 Bennett Rd., Richmond, Vancouver 14, B.C.*

M. G. Brechin, Supervisor of Material Planning, Canadian Pacific Air Lines Ltd., Vancouver Airport, B.C.: *670 Comstock Rd., Richmond, B.C.*

B. R. Brown, Chief, Aircraft Product Sales, Canadian Curtiss-Wright Ltd., Montreal, P.Q.: *3419 Ontario Ave., Montreal 25, P.Q.*

J. H. O'Hara, Military Sales and Missiles Div., Canadair Ltd., Montreal, P.Q.: *5731 Darlington Ave., Montreal, P.Q.*

A. M. Parry, Aviation Manager, Western Div., Shell Oil Co. of Canada Ltd., 1155 W. Georgia St., Vancouver, B.C.

C. M. Smith, Manager, The De Havilland Aircraft of Canada Ltd., Vancouver Airport, B.C.: *7116 Fleming St., Vancouver, B.C.*

SUSTAINING MEMBERS

NEWS

Canadair Ltd. reports that the R.C.A.F. Engineering Evaluation Board has now completed its work on the Argus and the aircraft has been advanced from the development to the production status.

Six of these aircraft are now flying on various trials — structural integrity and stability, cold weather operation, performance flying, armament and telecommunication equipment evaluation. Deliveries to Maritime Air Command for service are to begin in April, with aircraft No. 7 and subsequent.

It is also reported that Canadair Ltd. have acquired the world sales rights for a new medium-range turboprop transport, known as the Cosmopolitan (CL-66). The aircraft is a Canadian version of the Convair 440 fitted with Napier Eland 6 engines of 3,350 ehp each. The performance figures are: cruising speed 326 mph, capacity 44 to 60 passengers or 10,000 to 15,000 lb of cargo, with a maximum range of 1,700 miles. The aircraft has a gross weight of 53,200 lb, a length of 79 ft, span 105 ft and height 28 ft.

As a military transport, the aircraft will be available in a convertible utility version which offers a multitude of arrangements to satisfy military needs. The civil version will offer a great variety of commercial interior arrangements, including VIP interiors for corporate owners, airline interiors from 44 passenger standard to 60 passenger high density seating arrangements, and all-cargo versions with reinforced floor and a 10 ft wide loading door.

Since Convair is phasing out the 440, the tooling from San Diego will be available to Canadair, making it possible to get into full production of the Cosmopolitan by the middle of 1959. The R.C.A.F. has a contract for ten of these aircraft.

Railway & Power Engineering Corporation Ltd., as Sales Representative for the H. I. Thompson Company, has announced the development of "Astrolite", a new series of Refrasil reinforced plastic materials. This series has an enhanced resistance to high temperatures and excellent thermal shock characteristics. Full particulars are given in H. I. Thompson Bulletin PB 7-24.

Canadian Applied Research High-Low Temperature Chamber

Canadian Applied Research Ltd. is now running tests on its new $24,000 high-low temperature chamber. A temperature range exceeding −100°F to +300°F is possible, the low temperatures being obtained from a 35 hp compressor and the high from a 9 kw heating element.

Filling the tank with brine, ethylene glycol or alcohol, it is possible to run low temperature immersion tests on pieces of equipment. A test now under way concerns the performance of heating elements in the rubber de-icing boots of aircraft. The long length of the box (3′ × 3′ × 8′) allows the testing of such a large object as a section of a wing's leading edge.

A unique feature of the test chamber is its ability to maintain a constant temperature as low as −70°F even though 5 kw is being dissipated in the fluid.

Sealed ports in the sides allow the insertion of drive mechanisms and operating cables so that equipment may be operated while being tested.

Manufactured by Conrad, Inc., of Holland, Mich., the insulated chamber is built of 8 inch walls fitted with foamglass and styrofoam. The lid is lifted by pneumatic jacks.

Another item of interest is the linking of Canadian Applied Research with the Kearfott Company of Little Falls, N.J. The arrangement is for Applied Research to act as exclusive Canadian distributor in Canada for Kearfott products and is a result of the announcement made last September linking General Precision Equipment Corp. and A. V. Roe Canada Ltd., the respective parent companies of Kearfoot and Applied Research.

Finally, it is a pleasure to report that the U.S.A.F. has selected the Mk. 5 Airborne Profile Recorder, designed and manufactured by Canadian Applied Research, for installation in the Lockheed RC-130 aerial photographic and map-making aircraft.

Honeywell Controls Ltd. announce a new series of panel-mounted switches, featuring new type, snag-proof rocker-actuators designed to prevent accidental operation. These actuators are available in two key designs. Series TP1 is flush mounted and has removable translucent plastic keys. These switches feature edge-light control. From an external light source located inside the panel, the lowered half of the key emits a soft glow. This enables easy identification of the actuator position. Series TP4 is mounted above flush and has removable transparent plastic keys. An insert with specific information in signs, symbols, letters or colours can be placed under the key.

Designed to enhance the appearance of aircraft and computer panels, the new switches also feature integral terminal construction, coupled with a step-design case to provide ease of wiring and stronger terminals. The high-impact plastic case will resist carbon tracking from an electrical arc. There is a silicone seal between the bushing and the actuator to prevent dust or moisture from entering the switching chamber. A non-hardening, non-flowing sealant is used between the cover and the case. The cover is made from die-cast aluminum.

All the new rocker-actuated switches are applied with standard toggle switch contact arrangements. Special contact arrangements can be established to fit specific needs.

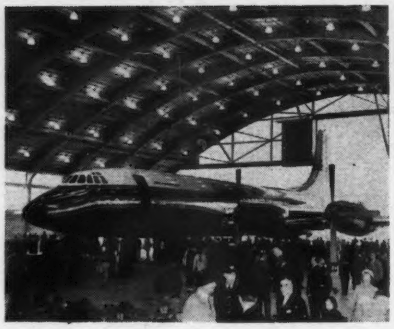
Under a 30 volt direct current, resistive load, the single-pole "1TP" is rated electrically at 40 amps, the two-pole "2TP" at 30 amps and the four-pole "4TP" at 20 amps.

Simmonds Aerocessories of Canada Ltd. recently moved from Montreal to Hamilton, as reported in the February issue of the Journal. The following additional information is now available.

Simmonds interests have been active in Montreal for a number of years and this is their second move to larger premises since 1952, before and since which date they have served the Canadian aircraft industry with the supply and servicing of proprietary aircraft accessories, such as fuel gauging equipment used in T.C.A.'s fleet of aircraft, and also mechanical engineering equipment used by other industries.

At their new premises, Simmonds plan gradually to expand their services and repair facilities, with the aim as soon as possible to utilize the available facilities to the fullest extent by manufacturing a selection of suitable components, for which they have exclusive Canadian rights, that are at present manufactured to Simmonds' specifications and orders elsewhere.

Avro Aircraft Ltd. are to be congratulated on the first flight of the Arrow 1 on the 25th March.



CPAL's first Britannia and new hangar

Canadian Pacific Air Lines Ltd. recently staged an official opening of their new large hangar and the accompanying photographs were taken on this occasion. The aircraft is the first of the six Britannias to be delivered.

APPOINTMENT NOTICES

The facilities of the Journal are offered free of charge to individual members of the Institute seeking new positions and to Sustaining Member companies wishing to give notice of positions vacant. Notices will be published for two consecutive months and will thereafter be discontinued, unless their reinstatement is specifically requested. A Box No., to which enquiries may be addressed (c/o The Secretary), will be assigned to each notice submitted by an individual.

The Institute reserves the right to decline any notice considered unsuitable for this service or temporarily to withhold publication if circumstances so demand.

Positions Required

Box 104 **Purchasing or Administration:** Purchasing man with 5 years experience in the aircraft accessories field requires position. Willing to relocate anywhere.

Positions Vacant

Technical Assistant: A vacancy exists for a Technical Assistant with a background of experience related to the overhaul of gas turbine fuel systems and accessories. Education to Engineering Standard or equivalent (Higher National Certificate). Applications should be made in writing only, giving complete outline of education, experience and salary required to Assistant Personnel Manager, Rolls-Royce of Canada, Ltd., Box 1400, Station O, Montreal 9, Que.

SUSTAINING MEMBERS

of the

CANADIAN AERONAUTICAL INSTITUTE

1958-59

AEROQUIP (CANADA) LIMITED
AIRCRAFT INDUSTRIES OF CANADA LIMITED
AIR-EX INCORPORATED
ALLOY METAL SALES LIMITED
AVIATION ELECTRIC LIMITED
AVRO AIRCRAFT LIMITED
BABB COMPANY (CANADA) LIMITED
BRISTOL AERO ENGINES LIMITED
BRISTOL AERO ENGINES (WESTERN) LIMITED
BRISTOL AEROPLANE COMPANY OF CANADA LIMITED
BRISTOL AIRCRAFT (WESTERN) LIMITED
B. W. DEANE & COMPANY
CAMPBELLFORD PRECISION PRODUCTS LIMITED
CANADAIR LIMITED
CANADIAN APPLIED RESEARCH LIMITED
CANADIAN CAR COMPANY LIMITED
CANADIAN PACIFIC AIR LINES LIMITED
CANADIAN PRATT & WHITNEY AIRCRAFT COMPANY LIMITED
CANADIAN STEEL IMPROVEMENT LIMITED
CANADIAN WESTINGHOUSE COMPANY LIMITED
CANNON ELECTRIC CANADA LIMITED
CARRIERE AND MACFEETERS LIMITED
COLLINS RADIO COMPANY OF CANADA LIMITED
COMPUTING DEVICES OF CANADA LIMITED
DECCA NAVIGATOR (CANADA) LIMITED
DECCA RADAR (CANADA) LIMITED
DEHAVILLAND AIRCRAFT OF CANADA LIMITED
D. NAPIER & SON LIMITED
DOWTY EQUIPMENT OF CANADA LIMITED
ELECTRODATA DIVISION OF BURROUGHS ADDING MACHINE OF CANADA LIMITED
ENAMEL & HEATING PRODUCTS LIMITED
FAIREY AVIATION COMPANY OF CANADA LIMITED
FIELD AVIATION COMPANY LIMITED
GARRETT MANUFACTURING CORPORATION OF CANADA LIMITED
GENERAL CONTROLS CO. (CANADIAN) LIMITED
GODFREY ENGINEERING COMPANY LIMITED
GOODYEAR TIRE & RUBBER COMPANY OF CANADA LIMITED
HONEYWELL CONTROLS LIMITED
IMPERIAL OIL LIMITED
JARRY HYDRAULICS
LUCAS-ROTAX LIMITED
MOFFATS LIMITED (AVCO OF CANADA)
NORMALAIR (CANADA) LIMITED
NORTHWEST INDUSTRIES LIMITED
OKANAGAN HELICOPTERS LIMITED
ORENDA ENGINES LIMITED
PHOENIX ENGINEERED PRODUCTS LTD.
PRENCO PROGRESS & ENGINEERING CORPORATION LIMITED
RAILWAY & POWER ENGINEERING CORPORATION LIMITED
ROLLS-ROYCE OF CANADA LIMITED
ROUSSEAU CONTROLS LIMITED
SHELL OIL COMPANY OF CANADA LIMITED
SIMMONDS AEROCESSORIES OF CANADA LIMITED
S. SMITH & SONS (CANADA) LIMITED
SPARTAN AIR SERVICES LIMITED
STANDARD AERO ENGINE LIMITED
THOMPSON PRODUCTS LIMITED
TRANS-CANADA AIR LINES
WALTER KIDDE & COMPANY LIMITED
YORK GEARS LIMITED

MEMBERSHIP OF THE C.A.I.

The qualifications and annual dues set out in the table below are those presently laid down by the By-laws. The rates of dues shown in brackets are those applicable to members resident outside Canada or the U.S.A.

The annual dues include a non-deductible subscription to the *Canadian Aeronautical Journal.*

Applications for membership must be made on the approved forms, which may be procured from the Secretaries of the Branches or from C.A.I. Headquarters. An applicant does not apply for membership in any particular grade, but each application is considered by the Admissions Committee, who decide the grade suitable to the applicant's qualifications. On admission, the applicant is informed of his grading and the appropriate entrance fees and annual dues.

The entrance fee is $5.00, except in certain special circumstances.

Grade	Summary of Qualifications	Annual Dues
Student	Undergoing a course of study at an approved school of engineering or technology	$3.00 ($2.00)
Junior Member	Engaged in technical work in aviation	$5.00 ($2.00)
Technical Member	Engaged in science, engineering, research, manufacture or operation, in aeronautics or related fields for 4 years or graduated from an approved school of engineering or science	$8.00 ($5.00)
Member	Engaged in technical work in aeronautics or related fields for 8 years and acquired a recognized standing	$10.00 ($6.00)
Associate	Engaged in aviation, though not qualified for technical grades	$15.00 ($10.00)
Associate Fellow	Engaged in aeronautical science or engineering for 10 years and been in responsible charge or made outstanding contribution	$15.00 ($10.00)
Fellow	Been an Associate Fellow for 1 year and attained distinction in aeronautics	$15.00 ($10.00)


RL 201

INSTRUCTIONS TO CONTRIBUTORS

The Canadian Aeronautical Institute invites the submission of papers, articles and technical notes for publication in the Canadian Aeronautical Journal. Following the practice of other societies, the Institute does not pay for contributions.

Authors should prepare their material in accordance with the following directions:

Manuscripts. Manuscripts should be
(a) Typewritten, double-spaced,
(b) On one side of 8½ x 11 white paper,
(c) With wide margins, approximately 1½", and
(d) With pages numbered consecutively.

Manuscripts must be in final form; the addition of material after acceptance by the Institute cannot be permitted.

Titles. The following form should invariably be adopted:—
(a) Titles should be brief;
(b) The name and initials of the author should be written as he prefers; (Rank or title preceding the name e.g. Wing Commander or Dr., should be included but abbreviations of degrees etc., after the name, should be omitted.);
(c) The name of the organization with which the author is associated should be shown under his name; and
(d) The author's position in the organization, referred to in (c) above, should be shown as a footnote to the first page.

Summaries. Each paper should be preceded by a summary
(a) Of 100 to 300 words, (10 to 35 lines, double-spaced),
(b) In non-specialist language, so far as possible,
(c) Stating the main conclusions of the paper.

Sub-Headings and Paragraph Numbering. Sub-headings should be inserted by the author at frequent intervals. Paragraphs should not be numbered.

References. References referred to by the author should be treated thus:—
(a) References should be numbered consecutively throughout the paper;
(b) An allusion to a reference should be indicated by a bracketed numeral e.g. "It has been shown by Dr. T. T. James (7) . . . ";
(c) Direct citation of a reference in the text should be written in full, e.g. "As shown in Reference (7) . . . "; and
(d) References should be grouped together in numerical order at the end of the paper, each showing
first, the numerical designation, e.g. "(7)".
second, the author's name, e.g. "James, T. T."
third, the title of his work, e.g. "Aerodynamics and Ballistics"
fourth, the title, volume, issue no, and date identifying the publication in which it appeared, e.g. "R.B.S. Journal, Vol. 7, No. 77, July 1907".
Thus "(7) James, T. T.,—Aerodynamics and Ballistics, R.B.S. Journal, Vol. 7, No. 77, July 1907."

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$$\frac{A}{B+C}$$
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